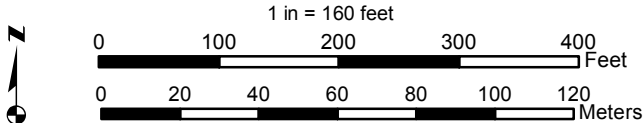


Map Date: 2/21/2012

Legend

- Parcel Boundary
- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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Datum: North American Datum, NAD83
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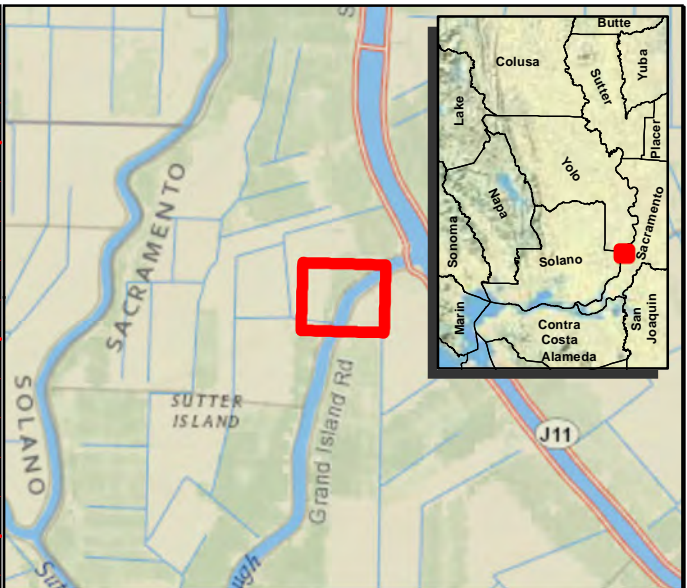
REAL ESTATE OWNERSHIP MAPS 2012
EROSION SITE: STM 25L

Revised to Measure 3: Adjacent Levee

Sacramento River Bank EIR/EIS

HDR 2365 Iron Point Road, Suite 300
Folsom, CA 95630-8709

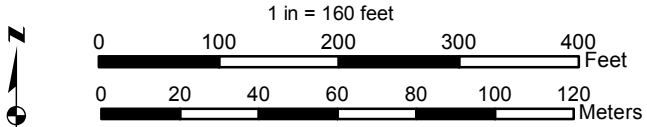




Map Date: 2/21/2012

Legend

- Parcel Boundary
- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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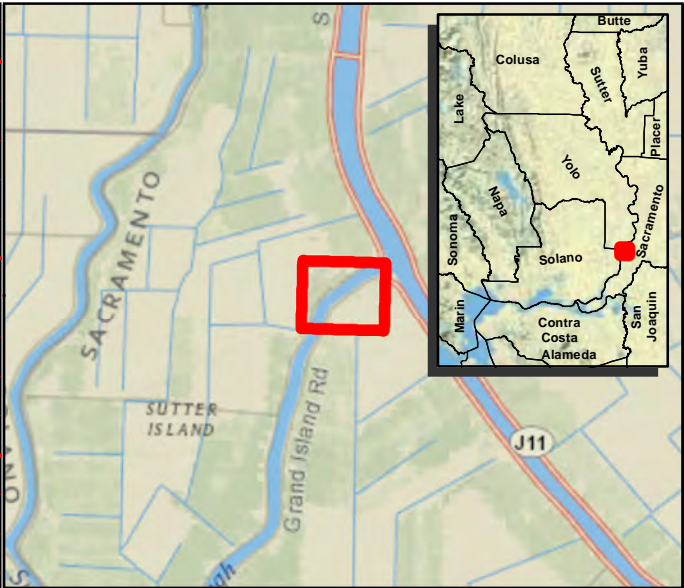
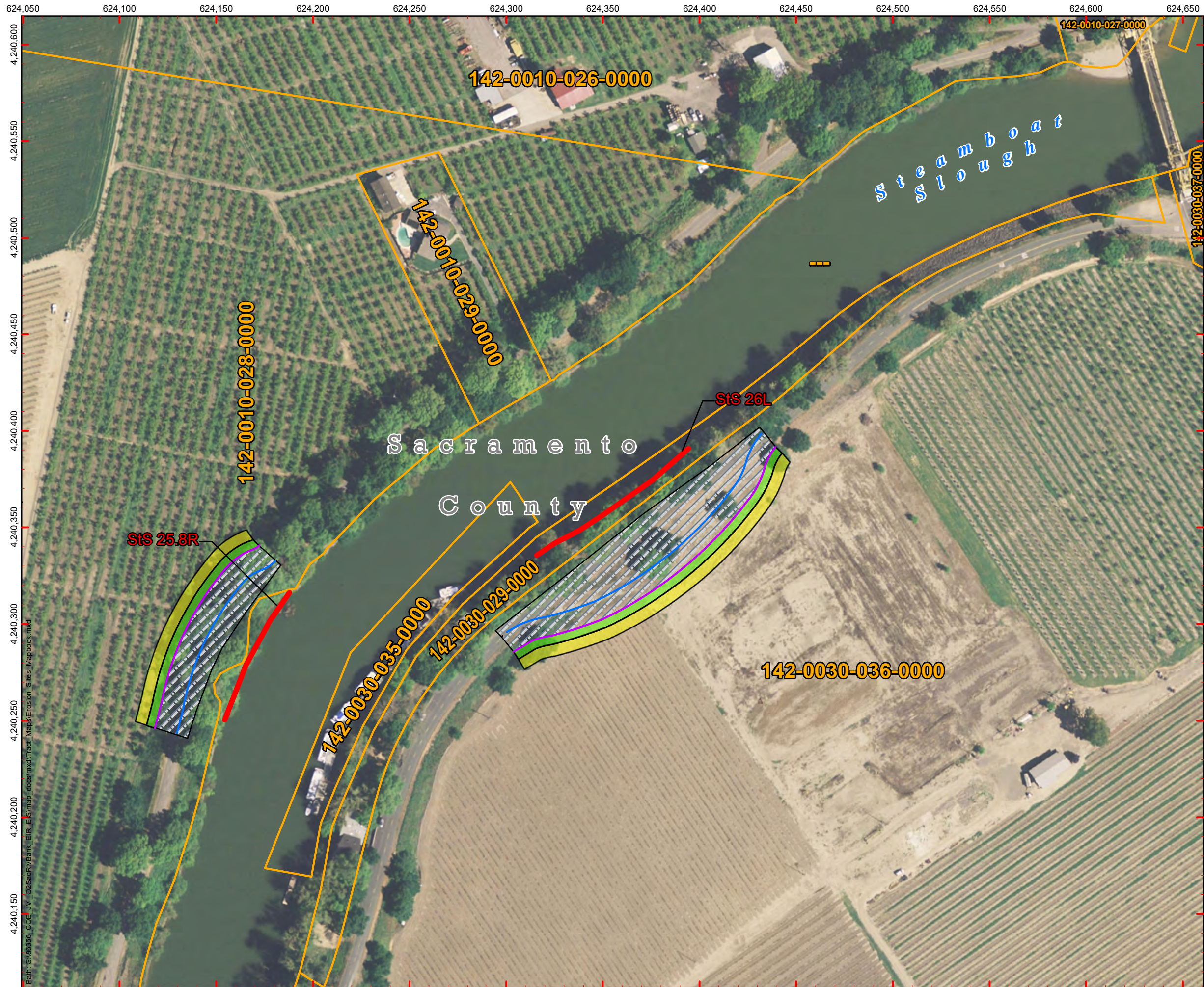
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REAL ESTATE OWNERSHIP MAPS 2012
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Revised to Measure 3: Adjacent Levee

Sacramento River Bank EIR/EIS

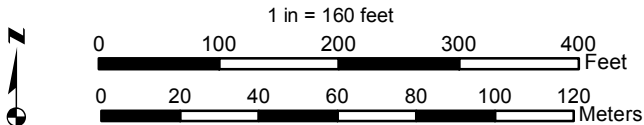




Map Date: 2/21/2012

Legend

- Parcel Boundary
- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



Metadata:
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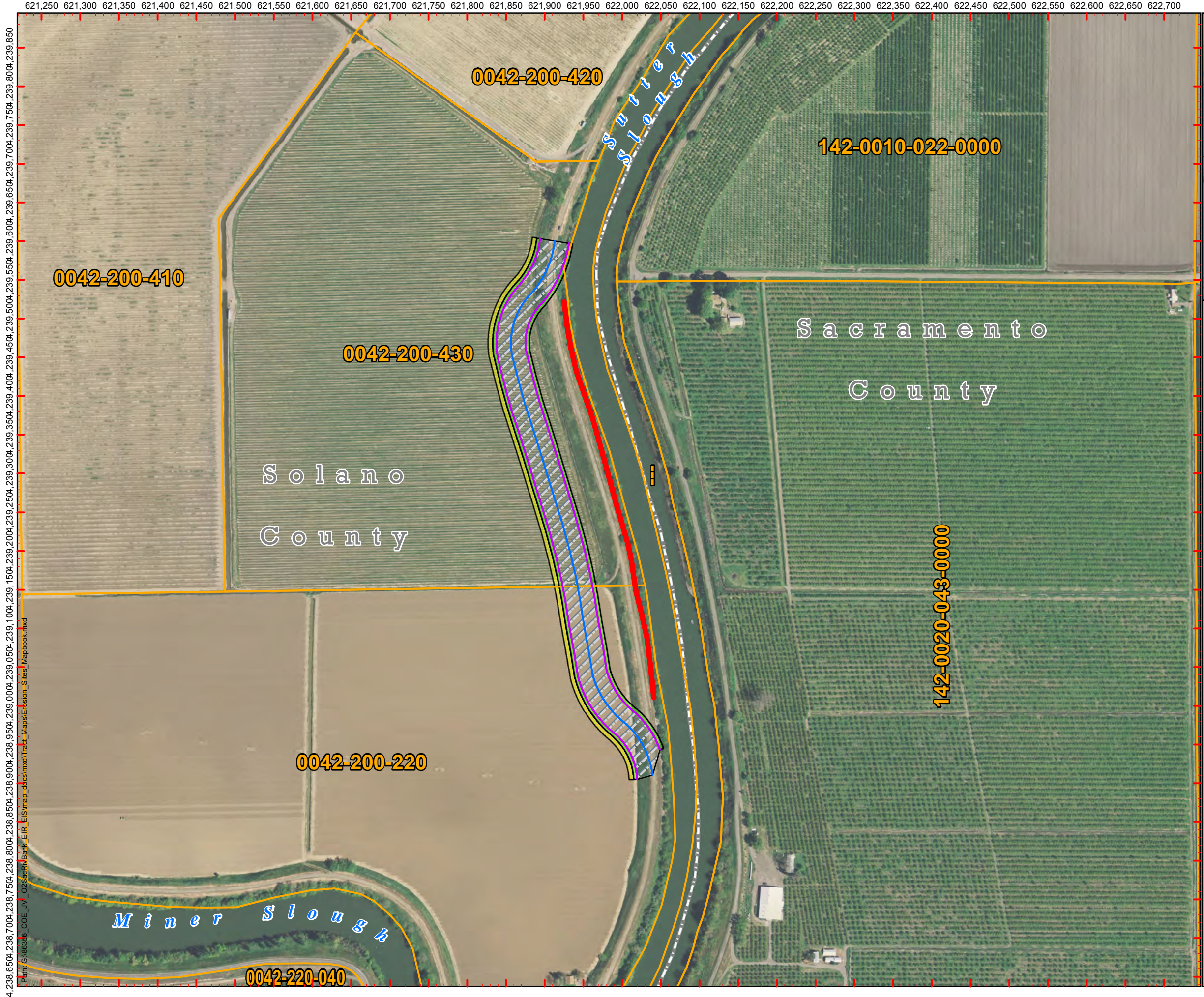
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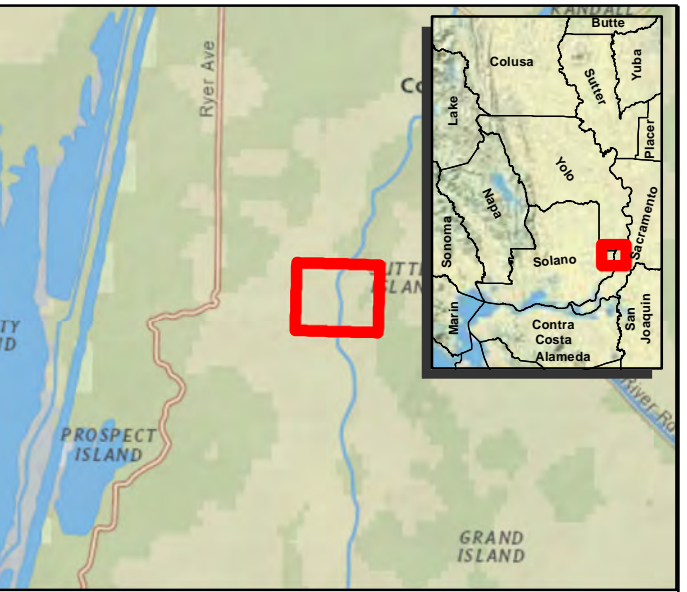
HDR 2365 Iron Point Road, Suite 300
Folsom, CA 95630-8709





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Map Date: 2/21/2012

Legend

- Parcel Boundary
- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe

1 in = 400 feet

0 100 200 300 400 500 600 700 800 900 1,000 Feet

0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 Meters

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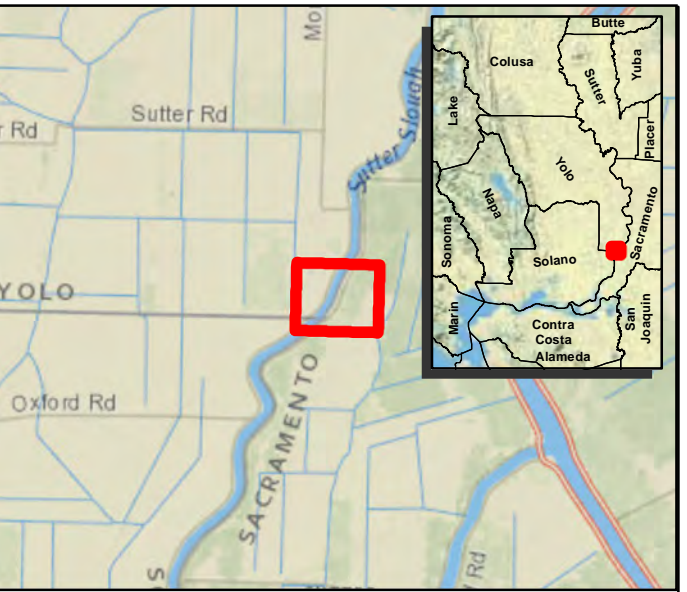
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Revised to Measure 1: Setback Levee

Sacramento River Bank EIR/EIS

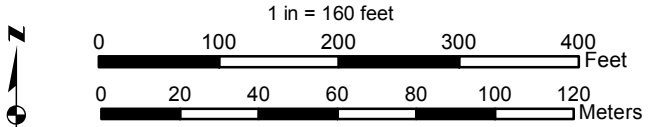
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Folsom, CA 95630-8709



Map Date: 2/21/2012

Legend

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- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



Metadata:
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AR Design 4, Measure 9

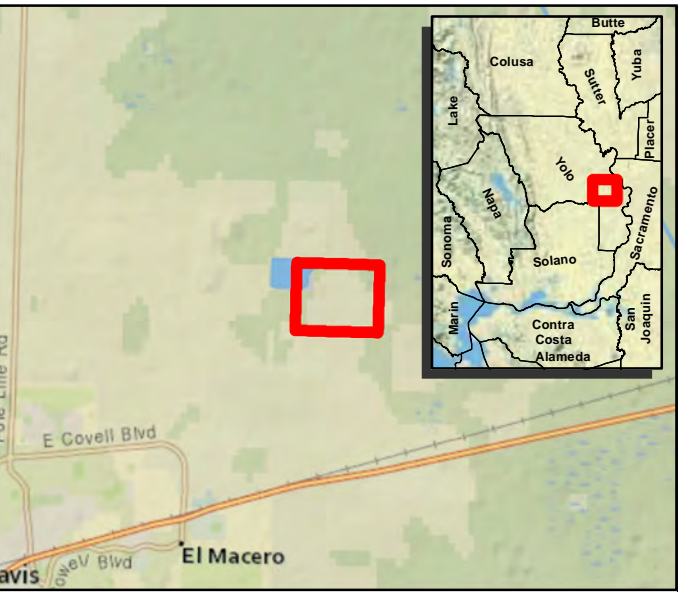
Sacramento River Bank EIR/EIS



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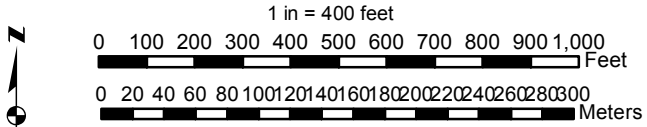
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Map Date: 2/21/2012

Legend

- Parcel Boundary
- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe




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REAL ESTATE OWNERSHIP MAPS 2012
EROSION SITE: WSB 0.2L

No Action

Sacramento River Bank EIR/EIS










2365 Iron Point Road, Suite 300
Folsom, CA 95630-8709



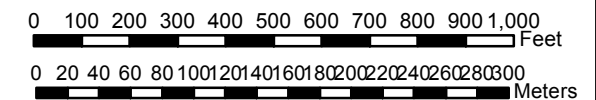


Map Date: 2/21/2012

Legend

-  Parcel Boundary
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-  Approximate Erosion Footprint
-  Temporary Construction Easement
-  O and M Easement
-  New Levee Centerline
-  New Levee Toe

1 in = 400 feet



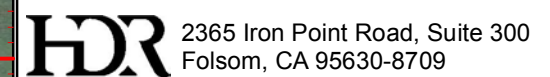
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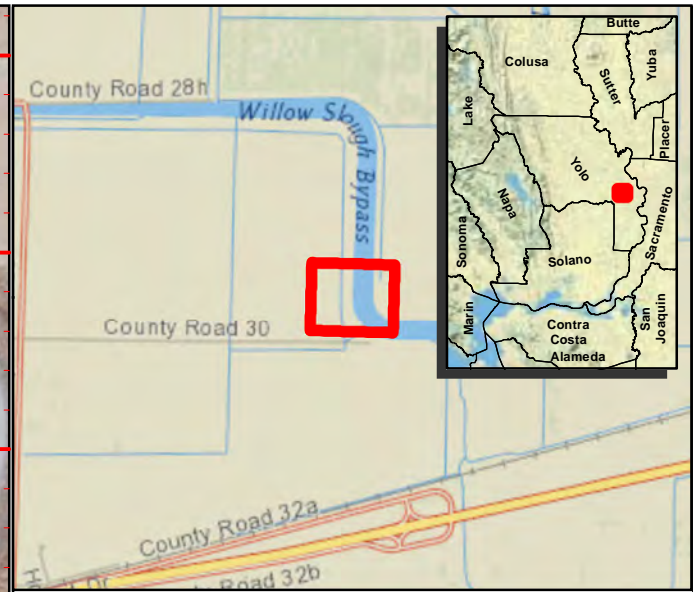
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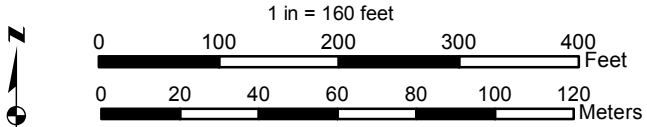




Map Date: 2/21/2012

Legend

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- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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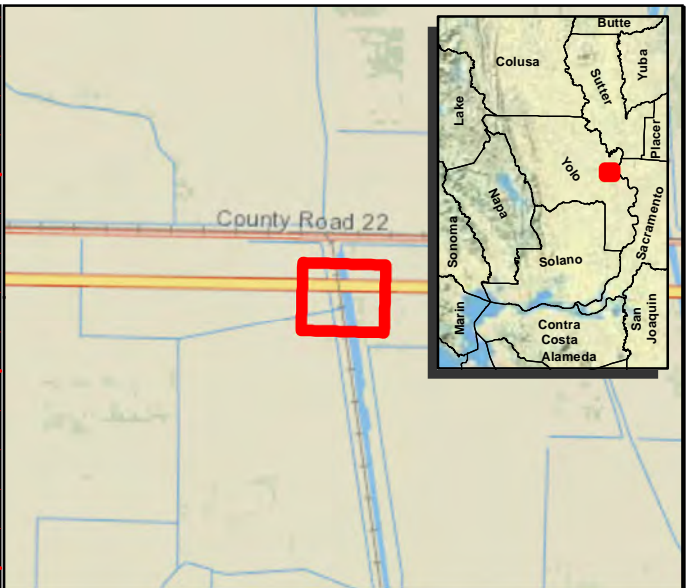
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Bank Fill Stone Protection with no On-Site Vegetation
Sacramento River Bank EIR/EIS





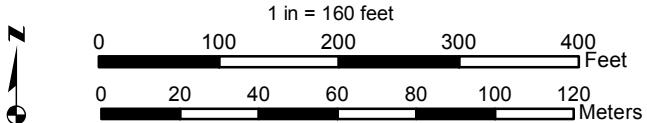
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Map Date: 2/21/2012

Legend

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- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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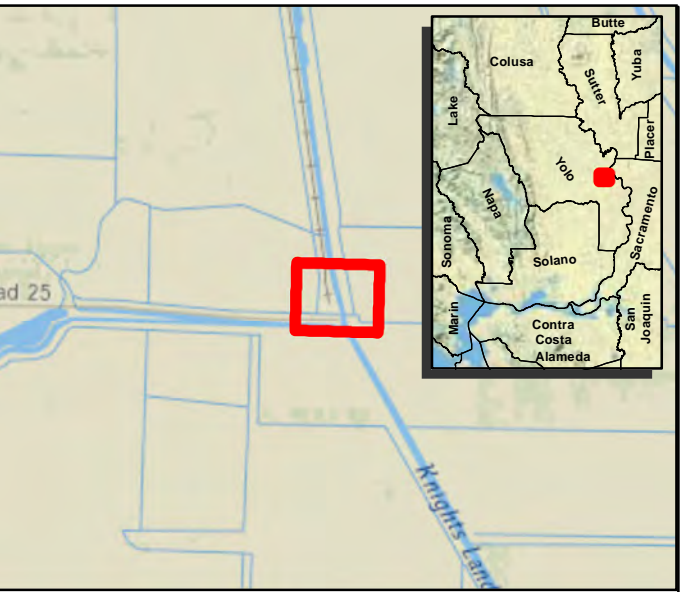
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REAL ESTATE OWNERSHIP MAPS 2012
EROSION SITE: YOL2 0.1R

Reused to Measure 2
Bank Fill Stone Protection with no On-Site Vegetation
Sacramento River Bank EIR/EIS

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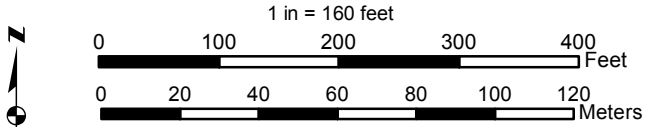




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Legend

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- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



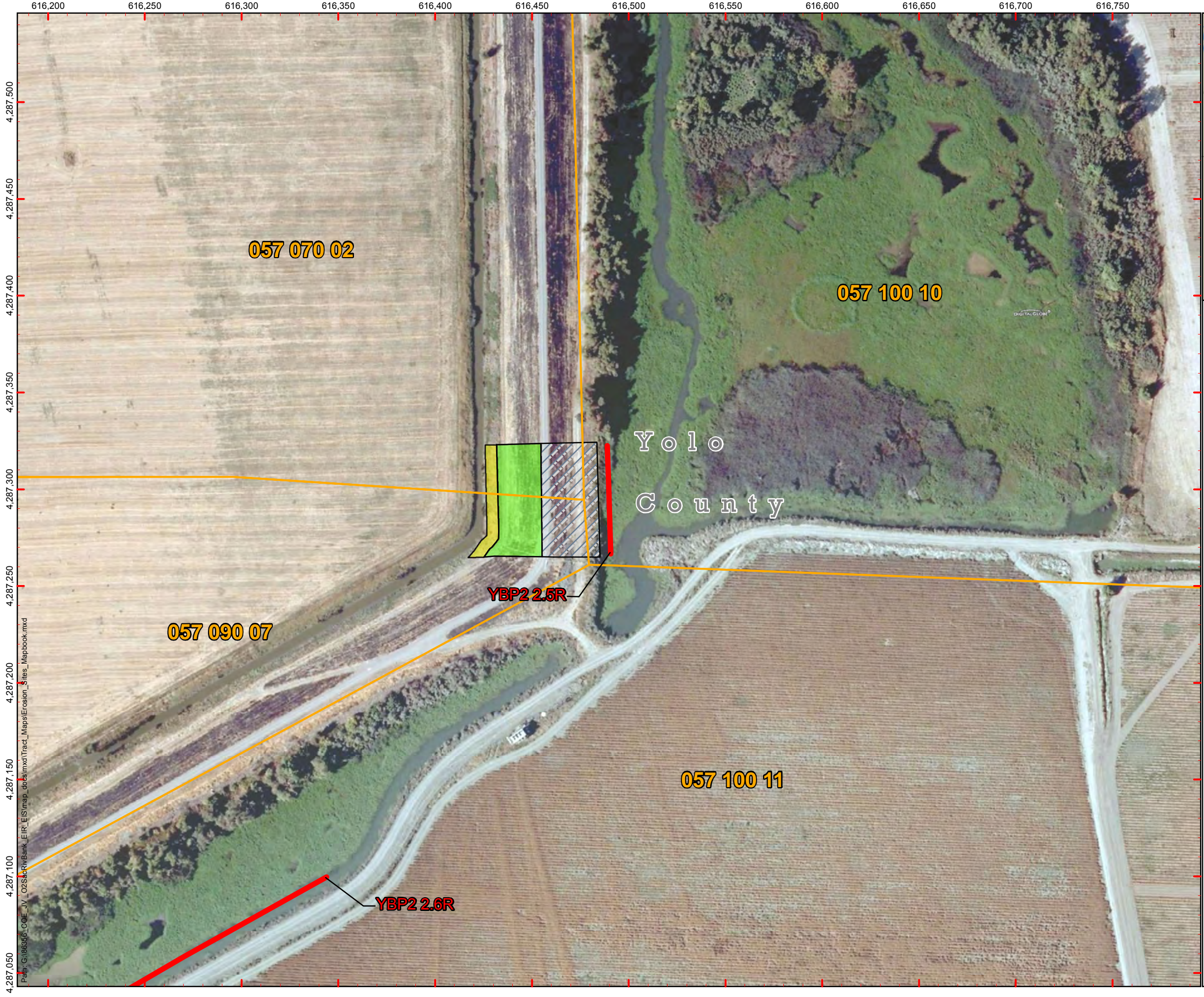
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REAL ESTATE OWNERSHIP MAPS 2012
EROSION SITE: YOL2 2.0R

Reused to Measure 2
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Sacramento River Bank EIR/EIS

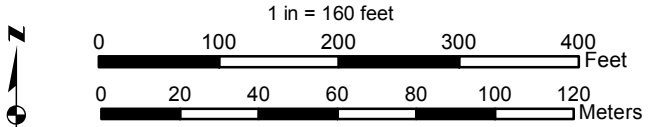




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Legend

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- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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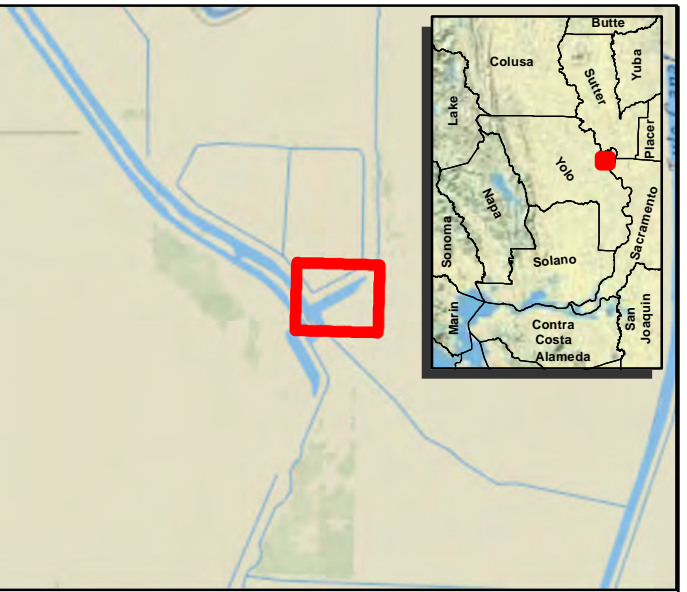
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AR Design 1, Measure 3

Sacramento River Bank EIR/EIS

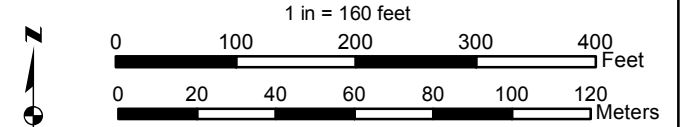
HDR 2365 Iron Point Road, Suite 300
Folsom, CA 95630-8709



Map Date: 2/21/2012

Legend

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- O and M Easement
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- New Levee Toe



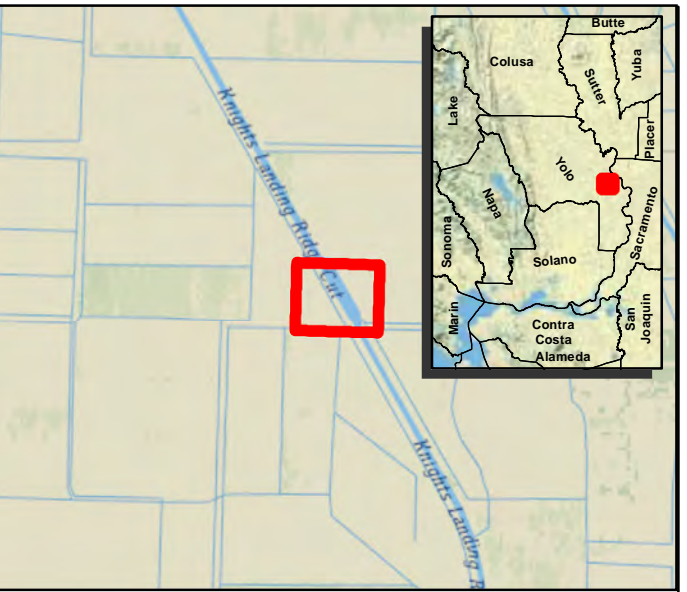
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No Action

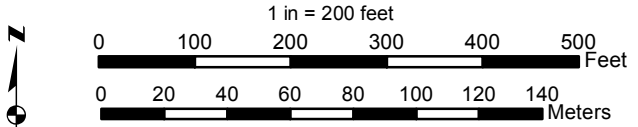
Sacramento River Bank EIR/EIS



Map Date: 2/21/2012

Legend

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- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



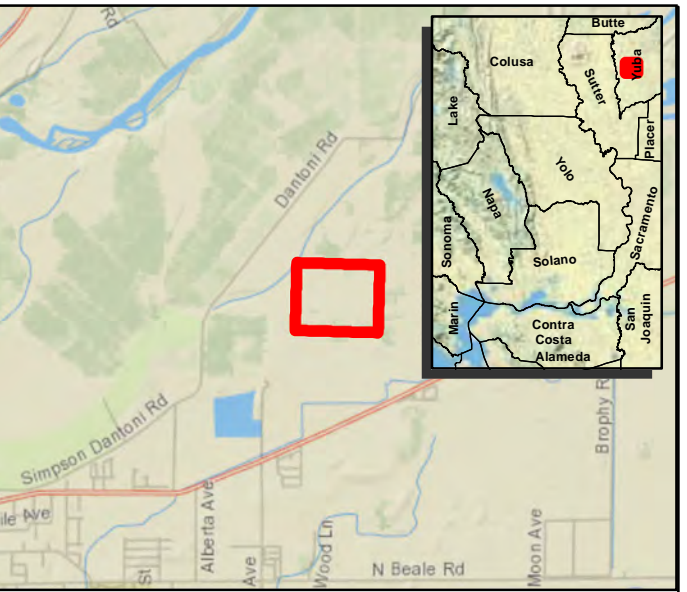
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Aerial Imagery: 2008-2009 Digital Globe

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REAL ESTATE OWNERSHIP MAPS 2012
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Revised to Measure 2
Bank Fill Stone Protection with no On-Site Vegetation
Sacramento River Bank EIR/EIS

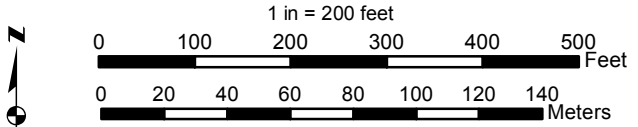




Map Date: 2/21/2012

Legend

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- Approximate Erosion Extent
- Approximate Erosion Footprint
- Temporary Construction Easement
- O and M Easement
- New Levee Centerline
- New Levee Toe



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REAL ESTATE OWNERSHIP MAPS 2012
EROSION SITE: YR 2.3L

AR: Rebuild

Sacramento River Bank EIR/EIS

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Subappendix 7. Standard Procedure for Updating the Sacramento River Flood Control Project Supplemental O&M Manuals

**STANDARD
OPERATION AND MAINTENANCE
MANUAL**

**FOR THE
SACRAMENTO RIVER
FLOOD CONTROL PROJECT**

(REVISED MAY 1955)

**SACRAMENTO DISTRICT

CORPS OF ENGINEERS
U. S. ARMY
SACRAMENTO, CALIFORNIA**

CORPS OF ENGINEERS

U. S. ARMY

STANDARD

OPERATION AND MAINTENANCE MANUAL

SACRAMENTO RIVER FLOOD CONTROL PROJECT

Prepared by the Sacramento District

Corps of Engineers, U. S. Army

Sacramento, California dated May 1955

**STANDARD OPERATION AND MAINTENANCE MANUAL
FOR THE SACRAMENTO RIVER FLOOD CONTROL PROJECT**

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B	"As Constructed" drawings Unattached (to be contained in supplements)
C	Control of Sand Boils, caving and bank protection, etc. Plates 1 to 10, incl.
D	Levee Inspection Report, Check List No. 1
E	Check Lists of Levees, Channel and Structures Unattached (to be contained in supplements)
F	Letter of Acceptance by State Reclamation Board Unattached (to be contained in supplements)
G	Suggested Semi-annual Report Form Unattached (to be contained in supplements)

STANDARD OPERATION AND MAINTENANCE MANUAL

of the

SACRAMENTO RIVER FLOOD CONTROL PROJECT

SECTION I

INTRODUCTION

1-01. Authority. The Sacramento River Flood Control Project was authorized by the Flood Control Act of 1 March 1917, Public 367 - 64th Congress, (H. Doc. 81, 62nd Congress, 1st Session, as modified by Rivers and Harbors Committee Doc. No. 5, 63rd Congress, 1st Session), and modified by the Flood Control Act of 15 May 1928, Public No, 391-70th Congress, (S. Doc. No. 23, 69th Congress, 1st Session), the River and Harbor Act of 26 August 1937, Public 392, 75th Congress, 1st Session (Senate Committee Print 75th Congress, 1st Session), and the Flood Control Act of 18 August 1947, Public 228, 77th Congress, 1st Session), (H, Doe. No. 205, 77th Congress, 1st Session).

1-02. Purpose of the Manual. The purpose of this manual is to present general information for use by local interests who maintain and operate the various geographical units comprising the Sacramento River Flood Control Project. This general information applies to all units of the project and conforms with Section 208.10, Title 33 of the Code of Federal Regulations as approved by the Acting Secretary of Army on 9 August 1944, and published in the Federal Register of 17 August 1944. A copy of the approved regulations is bound in this volume: as Exhibit A. Detailed information for each separate unit will be furnished under a separate Supplement Manual to be prepared when each unit is completed.

1-03. Location and Description. The Sacramento River Flood Control Project is located on the Sacramento River and the lower reaches of its principal tributaries in north-central California. The principal features of the project extend from Ord Bend downstream to Collinsville near the mouth of the river, a distance of 184 miles, and include a comprehensive system of levees, overflow weirs, drainage pumping plants, and flood bypass channels. This composite flood control project represents many years of planning and incorporates many plans of Federal and State agencies and local interests. The present project provides for the enlargement of the Sacramento River channel below the mouth of Cache Slough (about 20 river miles upstream from Suisun Bay); for making two cutoffs between the mouth of the Feather River and Colusa; for the construction of four bypass weirs and the reconstruction of Tisdale Weir; for construction of outfall gates at the mouth of Butte Slough

and at Knights Landing; for levees along certain reaches of the main river and tributaries; for drainage pumping plants on the east side of the Sutter Bypass; for bank protection work and levee setbacks on the main river and tributaries from Ord Bend to Collinsville; for maintenance of the enlarged river channel below Cache Slough during constructions including revetment of the banks of the cut; and for maintenance and operation of gaging stations on navigable rivers and streams during the construction period. The project also includes channel clearing, rectification, snagging, and bank protection along the Sacramento River and tributaries in Tehama County and from Red Bluff southerly. A map showing the location of the features of the project is included in the front of this manual.

1-04. Protection Provided. The Sacramento River Flood Control Projects, when completed, will provide adequate protection from all floods of record to about 800,000 acres of fertile agricultural lands; to the cities of Colusa, Yuba Citys Marysville, Sacramento, North Sacramento, West Sacramento and about eleven smaller communities; to other areas developed for residential and industrial purposes; to two transcontinental railways, one transcontinental highway, and other feeder railways and numerous State and County highways. It will make possible the reclamation of swamps and other areas which can be developed to a high degree when protection against flood hazard is assured.

1-0,5. Construction History. Prior to 1850, low levees were first constructed in the Sacramento Valley by a few individual landowners to protect their properties from inundation. Between the years 1855 and 1871 about 1,000,000 acres of swamp and overflow lands were transferred from Federal ownership to State ownership and in turn were sold to private interests. In an effort to reclaim these lands, levees were extended, encroaching on the streams and confining the waters. Land-owners then formed reclamation districts around which they constructed higher and more substantial levees to provide more protection. Federal participation in the improvement of the Sacramento River for flood control began with the Act of 1 March 1917, and continued under subsequent Acts as mentioned in paragraph 1-01.

SECTION II

LOCAL COOPERATION

2-01. Federal Requirements. The Act of 18 August 1941, provides that "The projects for the control of floods and other purposes in the Sacramento River, California, adopted by the Acts approved March 1, 1917, May 15, 1928, and August 26, 1937, Public 392 (Senate Committee Print, 75th Congress, 1st Session), are hereby modified substantially in accordance with the recommendation of the Chief of Engineers in House Document Numbered 205, Seventy-seventh Congress, first session."

The recommendation of the Chief of Engineers contained in House Document 205, 77th Congress, 1st Session, provides for the "completion of the Sacramento Valley Flood Control Project _____ subject to the provisions that the State of California, or responsible local agencies give assurances satisfactory to the Secretary of War that they will provide, without cost to the United States, all lands, easements and rights-of-way necessary for the completion of the project; bear the expense of necessary highway, railroad, and bridge alterations; hold and save the United States free from claims for damages resulting from construction of the works; and maintain and operate all works, after completion, in accordance with regulations prescribed by the Secretary of War."

2-02. State Legislation.

a. Adoption of Federal Policy. The original legislation adopting Federal policy requiring local interests to give assurances of local cooperation was enacted by the State of California on 22 June 1939, as outlined in State Senate Bill No. 950, Chapter 656. This legislation was later incorporated under Chapter 1528, Statutes of 1947, which amends Article 2 and adds Articles 4, 5, and 6 to Chapter 3, Part 2, Division 5 of the State Water Code. The approval and adoption by and on behalf of the State of California of the conditions, plans construction and mode of maintenance and operation of works within the Sacramento River Flood Control Project set forth in Senate Committee Print, 75th Congress, 1st Session, as authorized and approved by the Act of Congress, Public No. 392, 75th Congress, approved 26 August 1937, including the holding and saving the United States from damages due to construction works are continued in effect.

b. Powers and Duties of Department of Public Works and Reclamation Districts include the following:

"8360. On behalf of the State the Department of Public Works, acting by and through the State Engineer, has supervisory powers over the maintenance and operation of the flood control works of the Sacramento River Flood Control Project.

"8361. The department, acting by and through the State Engineer, shall maintain and operate on behalf of the State the following units or portions of the works of the Sacramento River Flood Control Project, and the cost of such maintenance and operation shall be defrayed by the State."

(a) The east levee of the Sutter By-pass north of Nelson Slough.

(b) The levees and channels of the Wadsworth Canal, the intercepting canals draining into it, and all structures incidental thereto.

(c) The collecting canals, sumps, pumps and structures of the drainage system of Project No. 6 east of the Sutter Bypass.

(d) The by-pass channels of the Butte Slough By-pass, the Sutter By-pass, the Tisdale By-pass, the Yolo By-pass and the Sacramento Bypass with all cuts, canals, bridges, dams and other structures and improvements contained therein and in the borrow pits thereof.

(e) The levees of the Sacramento By-pass.

(f) The channels and overflow channels of the Sacramento River and its tributaries within the Sacramento and San Joaquin Drainage District.

(g) The Knights Landing ridge cut flowage area.

(h) The flood relief channels controlled by the Moulton and Colusa Weirs and the training levees thereof.

(i) The levee on the left bank of the Sacramento River adjoining Butte Basin, from the Butte Slough outfall gates upstream to a point four miles northerly from the Moulton Weir, after completion.

(j) All weirs and relief structures.

(k) The west levee of the Yolo By-pass, extending from the west end of the Fremont Weir southerly to the Cache Creek Settling Basin and the east levee of the Yolo By-pass from the Fremont Weir southerly two miles.

(l) The levee on the west bank of Feather River extending a distance of about two miles southerly from the Sutter-Butte Canal headgate.

(m) The levees of Cache Creek and the easterly and westerly levees of Cache Creek settling basin.

"8370. It is the responsibility, liability and duty of the reclamation districts, levee districts, protection districts drainage districts, municipalities, and other public agencies within the Sacramento River Flood Control Project limits, to maintain and operate the works of the project within the boundaries of jurisdiction of such agencies, excepting only those works enumerated in Section 8361 and those for which provision for maintenance and operation is made by federal law.

c. Establishment of Maintenance Areas.

As amended by Chapter 7,5281, the State Water Code sets forth a procedure, available when necessary, whereby adequate and uniform maintenance of flood control projects may be secured. In substance, when the State Engineer finds that there is a failure on the part of local agencies to properly maintain project works or that a local agency no longer desires to carry out project maintenance, a report to that effect is made to the State Reclamation Board, which is empowered, after hearing, to form a "maintenance area" and thereafter the Department of Public Works maintains that particular unit of project works, and the Reclamation Board apportions the cost thereof upon the property benefited within the "maintenance area" on an ad valorem basis and the assessment is extended for collection together with county taxes on the county assessment roll.

SECTION III

GENERAL

3.01. General Rules and Procedures. The general rules for maintenance and operation of local flood-control works are, as follows:

a. The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

b. The State of California, the responsible local agency, which furnished assurance that it will maintain and operate flood control works of the Sacramento River Flood Control Project in accordance with regulations prescribed by the Secretary of Army as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

c. A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

d. No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

e. No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer, Corps of Engineers, or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer, or if otherwise obtained, shall, be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished the District Engineer after completion of the work.

f. It shall be the duty of the superintendent to submit a semi-annual report to the District Engineer covering inspection, maintenance and operation of the protective works.

g. The District Engineer or his authorized representative shall have access at all times to all portions of the protective works.

h. Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

i. Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the superintendent's organization during flood periods.

The District Engineer will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under these regulations. When special conditions do not permit full compliance with the general provisions of the Federal Control Regulations, or when conditions peculiar to a unit require additional care or attention, such supplement instructions will be contained in the supplement Manual concerned.

3-02. Clarification of Duties. Most of the general duties outlined above are self-explanatory; however, amplification of items b, e, f and i, is considered advisable to insure interpretation. Therefore, the remainder of this section of the manual furnishes suggestions for complying with those requirements.

3-0,3. Duties of Superintendent. Details of the duties of the Superintendent will be developed in other portions of the manual. The general duties should include the training of key personnel in such a manner that all contingencies may be handled in an expeditious manner. The Superintendent should ascertain that all of his key men have read those portions of the operation and maintenance manual pertaining to their duties. The Superintendent should have available the names, addresses and telephone numbers of all his key men and a reasonable number of substitutes therefor. These key men should, in turn, have similar data on all of the men necessary for assistance in the discharge of their duties. The key men should include the following:

a. An assistant to act for and in the absence of the Superintendent.

b. Section leaders in sufficient number to lead maintenance patrol work of the entire levee during flood fights. High qualities of leadership and responsibility are necessary for these positions.

The name and address of the Superintendent appointed by local interests to be responsible for the continuous inspection, operation and maintenance of the project works shall be furnished the District Engineer, and in case of any change of Superintendent, the District Engineer shall be so notified.

3-04. Proposed Improvements or Alterations. Drawings or prints or proposed improvements or alterations to the existing Flood Control Works must be submitted for approval to the District Engineer, Sacramento District, Corps of Engineers, Sacramento, California, sufficiently in advance of the proposed construction to permit adequate study and consideration of the work. Drawings or prints, in duplicate, showing any improvements or alterations as finally constructed should be furnished to the Corps of Engineers after completion of the work.

3-05. Semi-annual Report. The semi-annual reports required under Paragraph 208.10(a)(6) of the regulations should be submitted within a ten day period prior to 1 June and 1 December of each year and should include all dated copies of reports of inspections made during the period of report. Also, the nature, date of construction, and date of removal of all temporary repairs and the dates of permanent repairs should be included in this report. Other items and suggestions relative to public cooperation, public sentiment on the protection obtained, and other allied subjects are considered pertinent and desirable data for inclusion in the report, but are not required. A suggested form for the Semi-annual Report is included as Exhibit G of the Supplement Manuals.

3-06. Coordination with Operation of Public and Private Facilities. The Superintendent should have specific knowledge of all pertinent public utilities and private facilities located within the unit for which he is responsible in order to coordinate all phases of the flood fighting activities. Such knowledge should be extended to include the names, telephone numbers and addresses of all persons who might necessarily be contacted in case of damage to highway roads and bridges, railroads, power lines, telephone lines, gas lines or structures.

3-07. Safety Requirements. Since patrolling of levees, maintenance of channels and operation of irrigation or drainage structures will expose operating personnel to certain hazards, it is suggested that all pertinent safety codes be incorporated into operating procedures and that permanent operating personnel or temporarily employed personnel be given the necessary protective equipment and apparel together with instructions to conduct their work without undue exposure to existing hazards. Watchmen or patrols employed during flood periods should consist of teams of not less than two men.

3-08. Stream Flow Stages. Permanent arrangements should be made by the Superintendent with the Corps of Engineers at Sacramento, California, to secure stream flow stages and forecasts of stream flow stages and weather conditions of effected streams and drainage areas to properly plan adequate measures of protection.

3-09. Periodic inspections. Inspections should be made by the Superintendent at the times specified below:

- a. During the month of October, which is prior to the beginning of the flood season.

- b. Immediately following each major high water period.
- c. In the absence of high water, at periods not exceeding 90 days.
- d. At intermediate times as necessary.

3-10. Check Lists. The check lists shown in Exhibit D and E, should be used in each inspection to insure that no features of the protective system are overlooked. Items requiring maintenance should be noted thereon; if items are satisfactory they should be so indicated by a check. Exhibit E will be furnished by the Sacramento District Engineer as provided under paragraphs 403, 5-03, 6-03 and 7-03 of this manual.

3-11. Drawings. Detailed "As Constructed" record drawings and data necessary for the operation and maintenance of the protective works are included as Exhibit E of the supplement manuals.

SECTION IV

LEVEES

4-01. Description. The Sacramento River Flood Control Project has been divided into geographical units for ease of reference. These units usually conform to political subdivisions which are responsible for operation and maintenance of the project units within their boundaries. Levees of the various units are described in detail in the applicable Supplement Manuals which are prepared after completion of the construction work within the units. The extent of the levee system of the Sacramento River Flood Control Project is shown on the map in the front of this manual. The levees of the Project are constructed generally with a crown width of 20 feet, with landside slopes of 1 on 2 and riverside slopes of 1 on 3. Some bypass levees and some river levees do not have the standard slopes or crown widths. On the Sacramento River and tributaries the levee grade provides for a freeboard of 3 feet above adopted flood plane profile (5 feet freeboard below the mouth of Cache Slough) and on the bypass levees the freeboard is 6 feet. Reasons for departure from the standard conditions are explained in the Supplement Manuals. Patrol roads, earthen ramps, road crossings and turn-outs have been constructed at intervals or wherever necessary throughout the length of the levees.

4-02. Maintenance. Applicable portions of the Flood Control Regulations, paragraph 208.10(b)(1), pertaining to maintenance are quoted as follows:

"(b) Levees - (1) Maintenance. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. * * * * Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being carried out and further, to be certain that:

- (i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;
- (ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;
- (iii) No seepage, saturated areas, or sand boils are occurring;

- (iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;
- (v) Drains through the levees and gates on said drains are in good working condition;
- (vi) No revetment work or riprap has been displaced, washed out, or removed; (see also paragraph 4-05 a)
- (vii) No action is being taken; such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod; (see paragraph 4-05 b)
- (viii) Access roads to and on the levee are being properly maintained;
- (ix) Cattle guards and gates are in good condition;
- (x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;
- (xi) There is no unauthorized grazing or vehicular traffic on the levees;
- (xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days, and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accomplished during the appropriate season as scheduled by the Superintendent,"

4-03. Check Lists. A suggested check list form for reporting inspections of the levee is contained in this manual as Exhibit D. Additional check lists are contained in the Supplement Manuals as Exhibit E. As many copies of the form as are necessary to record all needed maintenance should be used for reporting such inspections.

4-04. Operation. Applicable portions of the Flood Control Regulations, paragraph 208.10(b)(2), are quoted as follows:

11(2) Operation. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

- (i) There are no indications of slides or sloughs developing;
- (ii) Wave wash or scouring action is not occurring;
- (iii) No low reaches of levee exist which may be overtopped;
- (iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section."

4-05. Special Instructions.

- a. Revetment work. Due to the fact that many reaches of levees with their contiguous banks have been constructed with stone protection work consisting of quarry stone or cobbles, the provisions of paragraph 4-02(b)(vi) are expanded to include the following:
 - 1. Where scour, wash, settlement or failure of a portion of the originally provided stone protection has been noted, or where inspection indicates that such damage may result during the next flood or high water period, the scour or wash shall be filled with earth free from brush, roots, sod or other unsuitable material and additional stone shall be placed upon the earth fill to bring the stone protection to its original section. In case of emergency and when stone is not available, sand bags or bags filled with gravel may be used for temporary repair measures.
 - 2. When permanent repair of the stone protection is made, the stone used shall, as far as possible, be similar to the kind and gradation as originally used, and shall be

placed to the thickness as shown on the drawings of Exhibit B. In the reach of the Sacramento River downstream from Walnut Grove where the levees are subject to excessive wave wash and at other locations where filter was originally placed or where it may be required, repair of stone protection will include the placement of a properly graded six inch filter layer under the stone protection.

3. In the event an inspection reveals that due to scour, settlement or other causes, stone protection on the levee or bank is required beyond the limits of the original construction or in reaches of the levee or bank not originally provided with such protection, local interests will provide additional sloping of the bank and placement of stone protection as needed to protect completed work. The work shall be done in a manner acceptable under standard engineering practice. Drawings or prints showing such improvements or alterations shall be furnished the District Engineer after completion of the work.
- b. Care of vegetation on levee. Due to conditions peculiar to this area, the growth of sod on the levee slope is not practicable. Accordingly, the following special instructions are furnished in lieu of paragraph 4-02(b)(vii) of the prescribed general regulations:
1. The Superintendent shall provide for clearing of brush, trees, and other wild growth from the levee crown and slopes. Brush and small trees may be retained on the waterward slope where desirable for the prevention of erosion and wave wash.
 2. Weeds, grasses, and debris on the levee may be burned during appropriate seasons, where not dangerous or impracticable, in order to permit the detection of cracks, holes, burrows, slips, and other damage and to permit the detection and extermination of burrowing animals. Grass and weeds on levee slopes should be mowed where removal by burning is dangerous or impracticable, such as on peat levees or where burning would constitute a hazard."

- c. Repairs to Levee Embankment. Methods used for repair or reconstruction of the levee fill will depend on the extent of the damaged section. If of small extent, the most suitable method will be to bring the levee back to line and grade by a fill made in 6-inch layers of earth free from brush, roots, sod or other unsuitable matter. If of larger extent, the fill should be made in the same manner as the original construction, of selected material from borrow pits approved for the project, placed in uniform layers of loose material and not more than 6 inches in depth and compacted in accordance with the specifications under which the work was completed or compacted according to approved construction practices.
- d. Depredations of Burrowing Animals. Dens and runways formed within the levee by burrowing animals are frequently the causes of levee failures during flood stages, Burrowing animals such as muskrats, ground hogs, ground squirrels, moles and gophers, found in the levee should be exterminated. The dens and runways should be opened up and thoroughly compacted as they are backfilled. Levees kept properly cleared are not seriously menaced by burrowing animals as they prefer areas where a protective cover, such as high grass, weeds, and brush, is found. Several methods of extermination are found effective, such as trapping, baiting, and poison gases, depending on the type of animal present and the time of year the work is done. Advice concerning the best methods in each locality can be obtained from the County Agricultural Agent.
- e. Access Roads. Access roads to the levees shall be maintained in such condition that they will be accessible at all times to trucks used to transport equipment and supplies for maintenance of flood fighting.

Compliance with the provisions prescribed in the general regulations quoted in paragraph k-02 above and with the special instructions is essential for the efficient maintenance of the levee system covered by this manual and for the successful operation of the entire Sacramento River Flood Control Project.

SECTION V

IRRIGATION AND DRAINAGE STRUCTURES

5-01. Description. This section of the manual deals with the numerous irrigation and drainage structures which pass through, under or over the levees to provide for the passage of water from the waterway to the protected area for irrigation or other usage or from the protected area to the waterway for drainage purposes. In general, these structures are constructed of corrugated metal pipes, steel pipes or reinforced concrete pipes or culverts all controlled on the riverside with positive closure devices accessible during high water or with automatic flap gates. Detailed descriptions of the individual structures are contained in the applicable Supplement Manuals.

5-02. Maintenance

a. Flood Control Regulations. Applicable portions of the Flood Control Regulations, paragraph 208.10(d)(1) pertaining to maintenance of irrigation or drainage structures are quoted as follows:

"(d) Drainage Structures (1) Maintenance. Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash drift or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled and trial operated at least once every 90 days. * * * * Periodic inspections shall be made by the Superintendent to be certain that:

- (i) Pipes, gates, operating mechanism, riprap and headwalls are in good condition;
- (ii) Inlet and outlet channels are open;
- (iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;
- (iv) Erosion is not occurring adjacent to the structures which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspection."

b. At each inspection as required above, the following items, if applicable, shall be particularly noted:

- (1) Debris or other obstructions to flow.
- (2) Damage or settlement of pipe.

Condition of concrete-cracks, spalls, erosion.

c. Maintenance.

(1) All eroded concrete shall be repaired as soon as erosion reaches a depth of 4 inches or any reinforcing steel is exposed. All evidences of settlement, uplift, or failure of concrete should be referred to the State Engineer for analysis and recommendation of remedial measures.

(2) If the inspection shows that the automatic drainage structures have been, jammed in an open position by debris or other obstructions, they shall be thoroughly cleaned so that they swing freely to a true closure. If any parts of the gates have been damaged or broken, they shall be replaced by new parts.

(3) Compliance with the provisions prescribed above pertaining to drainage structures is essential for proper maintenance of the levee system covered by this manual. Levee failures caused by neglected drainage structures are of common occurrence; it is, therefore, of utmost importance that these structures always be kept in perfect working condition in accordance with the regulations.

(4) Care should be taken not to bury any of the side drainage inlets in the event that it becomes necessary to fill any of the lowlying pockets in back of the levee. Plans for the maintenance of drainage facilities at any such points should be submitted to the State Engineer for approval before such work is started.

5-03. Check Lists. A form suggested as a check list for reporting inspections of drainage structures will be found in the Supplement Manuals, Exhibit E. As many copies of the form as necessary to record all needed maintenance should be used for reporting such inspections.

5-04. Operation. Applicable portions of the Flood Control Regulations, paragraph 208.10(d)(2), are quoted as follows:

"(2) Operation. Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition."

5-05. Additional Requirements.

a. Inspection. Periodic inspections should be made to insure that all facilities are in good operating condition as follows:

- (1) Since the outlets of pipes crossing under the levee are inundated at relatively low river stages, all pipes crossing under the levee should be inspected considerably in advance of the beginning of the flood season. The gates on these pipes should be checked at the same time.
- (2) Inspection of all drainage structures should also be made following each major high water period.
- (3) Otherwise at periods not exceeding 90 days.

b. Check Lists for Inspection of Drainage Structures. Check lists suggested under Exhibit E of the Supplemental Manuals should be used in each inspection to insure that structures are kept in working condition at all times. Exhibit E will be furnished by the Sacramento District Engineer as provided under paragraph 5-03 of this manual.

e. Positive Closure Devices. It is essential that the prime function of the flood protection works cannot be nullified by back flow through irrigation and drainage structures. Accordingly, a reliable means of positive closure of conduits must be provided on the riverside of the protective works and such closure devices must be accessible during flood periods. Conduits through the flood protection works fall into two categories and the requirements for each are as follows:

- (1) Those located through the levee above the project flood plane. Emergency closure devices will not be required on those structures where they connect canals and drains which have ample capacity to handle any flow which might pass through the pipe during floods. Where such outlets are not connected to canals or drains of ample capacity an accessible closure device will be required on the river side.
- (2) Those located through the levee below the project flood plane. All structures installed by the Federal Government and all new structures to be installed under permit by local interests will be required to have an accessible closure device on the riverside of the levee. All existing structures which do not have an accessible closure device on the riverside of the levee will be modified by local interests to meet that criteria when the structure is rebuilt or modified in any way. Where it is evident that it may be some years before riverside closures will be provided on existing outlets which are at present ungated on that side, it is essential that local interests place, at an early date, an emergency flap gate on the riverside of each outlet now ungated on that side. The flap gate is to be equipped with a cable extension to be equipped with a cable extension to

the levee crown, or other device to hold it open except when necessary to be released for emergency closure of the pipe.

5-06. Safety Requirements. In removing large objects which have lodged against gate structures during periods of high water, exposed workmen should be provided with life vests and, if necessary, should have a safety line attached to their person attended by another worker. Similar hazardous work in the vicinity of structures should not be attempted unless two or more persons are present.

Compliance with the maintenance provisions prescribed in Paragraph 5-02 above pertaining to drainage structures is essential for proper maintenance of the levee system covered by this manual. Levee failures caused by neglected drainage structures are of common occurrence; it is therefore of utmost importance that these structures always be kept in perfect working condition in accordance with the regulations.

SECTION VI

CHANNELS

6-01. Description. The channels of the Project constitute that part of the waterway which lies between the levees of the Sacramento River from Ords Ferry to Collinsville; the channels of the lower reaches of the Feather and American Rivers; and all tributary and distributary streams. The area in general is shown on the map located near the front of this manual. More complete detailed descriptions and limits of channels are contained in the Supplement Manuals.

6-02. Maintenance.

a. Flood Control Regulations. Applicable portions of the Federal Flood Control Regulations, Paragraph 208.10(g)(1), pertaining to maintenance of channels are quoted as follows:

"(g) Channels and Floodways--- (1) Maintenance.

Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

- (i) The channel or floodway is clear of debris, weeds, and wild growth;
- (ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;
- (iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;
- (iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;
- (v) Riprap sections and deflection dikes and walls are in good condition;
- (vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. . . .'

b. Other Maintenance Requirements. The purpose of the floodflow channels inspection and maintenance is to insure that conditions which affect the channel capacity will remain substantially the same as those considered in the design assumptions and that no new conditions develop that may affect the stability of the project structures. Channel maintenance along navigable waterways relates to such maintenance as is required for flood control and is not to be confused with the snagging, clearing and dredging operations carried on by the United States in conjunction with maintenance of Federal navigation projects. Maintenance along channels which are not navigable waterways are the sole responsibility of local interests when such channels must be maintained to a certain capacity for flood control. Particular attention will, therefore, be given the following:

(1) Weeds and other vegetal growth in the channel shall be cut in advance of the flood season and, together with all debris, removed from the channel.

(2) Operations of any nature upstream from the project that would affect flow conditions.

(3) Shoaling or aggradation at the inlets or outlets of side drainage structures may render them inoperative. It is, therefore, imperative that all drains be kept cleaned out and unobstructed at all times.

(4) Dumped rock or other suitable types of protection should be placed at locations found by experience to be critical trouble points, with a view to stabilizing the channel alignment and preserving the general uniformity of the bank lines.

(5) Sediment, rubbish, industrial waste or any debris plugs or other obstructions should be removed from the channel to prevent any tendency for the flows to be deflected within the channel. The heavy material likely to accumulate in the new channel at the mouths of tributaries should be removed to keep the channel clear.

(6) All eroded concrete shall be repaired as soon as reinforcing steel is exposed or erosion reaches a depth of 4 inches. For this purpose, it is recommended that the repair be made by thoroughly cleaning the surface by sandblasting and building up the section with pneumatically placed Portland cement mortar. All evidence of settlement, deviation from grade, uplift, or failure of concrete structures shall be referred to the State Engineer for analysis and remedial measures.

(7) All damage to fencing, posts, barbed wire or galvanizing whether resulting from accidental or willful injuries or from corrosion, shall be promptly repaired with new material in order to maintain satisfactory protection to the public.

(8) Earth fills should be checked for settlement, erosion of levee slopes, excessive seepage or saturation area back of fills and condition of bank protection - concrete or stone blanket.

(9) Right-of-way should be checked for presence of dumped refuse and encroachment of trespass.

6-03. Check Lists. A form suggested as a check list for reporting inspections of the channel will be found in the Supplement Vsual, Exhibit E. As many copies of the form as necessary to record all needed maintenance should be used for reporting such inspections.

6-04. Operation.

a. Pertinent Requirements of the Code of Federal Regulations, Par. 208.10(g)(2), are quoted in part as follows:

"(g) Channels and floodways(2) Operation. Both banks of the channel shall be patrolled during periods of high water Appropriate measures shall be taken to prevent the formation of jams..... of debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway, shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter all snags and other debris shall be removed and all damage to walls, drainage outlets or other flood control structures repaired."

6-05. Safety Requirements.

a. Clearing of channels present hazards which, unless foreseen and guarded against, may result in serious consequences. Clearing the channel of growing vegetal matter involves the use of axes, brush-hooks or other sharp edged hand tools. In order that the work may be accomplished with a minimum of exposure, the following precautions should be observed:

(1) Instruct employees in proper use of tools and equipment.

(2) Keep tools sharp and inspect tools for possible loose or warped handles or lack of proper wedges.

(3) Allow sufficient distance between workers.

(4) Clear area of branches or vines which might deflect swing of axe.

(5) When clearing channel of debris, workmen should be cautioned to keep a sharp lookout for poisonous snakes.

(6) Extra care should be taken to prevent exposure of susceptible workmen to poison oak.

(7) Should it become necessary to remove large objects which have lodged against the bank or which are causing an obstruction to the flow, during the period of high water, workmen who may be exposed to water hazards should be provided with life vests and, if necessary, should have a safety line attached to their person, attended by another worker.

SECTION VII

MISCELLANEOUS FACILITIES

7-01. Description. Miscellaneous structures or facilities which are constructed as a part of, or exist in conjunction with the protective works, and which might affect their functioning, include bridges, utility crossings, hydrographic facilities, road crossings and other structures not classified as drainage or irrigation facilities. Detailed description of individual structures or facilities pertinent to each unit will be contained in the supplement manual.

7-02. Maintenance.

a. Applicable portions of the Federal Regulations, paragraph 208.10(h)(1), are quoted as follows:

"(h) Miscellaneous Facilities. (1) Maintenance.

Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be replaced without delay. . ."

b. Inspection of the miscellaneous facilities and maintenance requirements shall be made at the same time that the inspection of the other features of the project are made, and shall be reported on check list Exhibit E, as shown in the Supplement Manuals.

c. The interest of the Corps of Engineers and the responsibility of the local interests in the existing highway and railroad bridges is primarily confined to their effect on the safety and functioning of the flood control works. However, any conditions noted in the inspections that may affect them in any way should, as a matter of courtesy, be brought to the attention of the responsible agencies. If the inspection of any miscellaneous structure (either existent or constructed in the future under permit) discloses any condition that indicates the probability of failure during periods of high water, the Superintendent shall address a letter to the owner of the structure, quoting this manual as authority and inviting attention to the conditions observed and requesting that immediate steps be taken to correct them. A copy of such letter shall be forwarded to the District Engineer for his information. A report on the action taken by the owner shall be submitted to the District Engineer to accompany the next semi-annual report.

7-03. Check Lists. A check list for miscellaneous structures has not been prepared. A check list similar to that found in the Supplement Manual, Exhibit E, may be used by local interests.

7-04. Operation.

a. Flood Control Regulations. Applicable portions of the Federal Flood Control Regulations, paragraph 208.10(h)(2), are quoted as follows:

"(2) Operation. Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor."

SECTION VIII

SUGGESTED METHODS OF COMBATING FLOOD CONDITIONS

8-01. General. Most of the methods described herein have been developed during years of experience with the various problems that often come up during periods of high water, and they are not intended to restrict the Superintendent, or others concerned, to a rigid set of rules for every condition that may arise. The remarks are primarily concerned with the earthen portions of the levee system. If problems not covered by these suggestions arise, where the Superintendent is in doubt as to the procedure to be taken, he will be expected to consult the District Engineer, U. S. Corps of Engineers, Sacramento, California, and subsequently to follow standard engineering practices in meeting the situation. It should be noted that it is much better to be over-prepared for a "flood fight" than to find at the last moment that preparations are incomplete or unsatisfactory. Confidence of the protected persons and firms is a valuable asset that should not be carelessly lost through inefficient operation of the protection system in time of emergency.

8-02. Earthen Levees. An earthen levee is in danger whenever there is water against it. This danger increases with the height of the water the duration of the flood stage, and the intensity of either the current or wave action. A well-constructed levee of correct cross section should if properly maintained and not overtopped, hold throughout any major flood. Threatened failures, such as sand boils, sinking levees, slides, or sloughing can be met if prompt action is taken and proper methods of treatment are used.

8-03. Premeditated Damage. In the event of an extraordinary flood requiring a fight over long stretches of levee on both sides of a river, there is a natural temptation to attempt some relief from the strain by breaking the opposite levee. The Superintendent should continually guard against premeditated damage to the levee, and when the situation demands immediate action should be taken to establish adequate protective forces.

8-04. Security. Personnel of the Corps of Engineers, whether military or civilian, are not vested with any civil police authority in the performance of their engineering duties, and they will not attempt to exercise any such authority. The responsibility for protecting flood control works against sabotage, acts of depredation, or other unlawful acts vests with the local interests through local and State Governmental agencies.

8-05. Inspection of Flood Control Works. Immediately upon receipt of information that a high water is imminent, the Reclamation Districts through their Superintendents, should form a skeleton organization, capable of quick expansion, and assign individuals (Sector Foremen) to have charge of definite sections of levees. As his initial activity, each Sector Foreman should go over his entire sector and parts of adjacent sectors, making a detailed inspection, particularly with reference to the following matters:

a. Sector limits; ascertain that the dividing line between sectors is plainly determined and., if necessary, marked.

b. Condition of new levees and recent repairs.

c. Condition of culverts, flap gates, and sluice gates.

d. Transportation facilities; roads, rail and water communications.

e. Material supply; quantity, location, and condition.

f. Communications; locate and check all necessary telephones in the sector.

8-06. Preliminary Repair Work. After the initial inspection has been made, each Sector Foreman should recruit a labor crew and provide it with tools such as shovels, axes, wheelbarrows, etc. In additions bulldozers, scrapers trucks, etc., should be located and made ready for use in case of emergency. Then immediate action should be taken to perform the following work:

a. Fill up holes or washes in the levee crown, slopes, and landslide berms. Where new construction has been completed during the year, rain washes and deep gullies may have developed. When the levee is new, preparations should be made in advance to combat wave wash along the exposed reaches.

b. Repair gaps where road crossings have been worn down and the levee is below grade. In filling the road crossings, it may be necessary to obtain material from landside borrow pits, in which case excavation for the material should be kept at least 50 feet from the toe of levee. Any filling done in this connection should be tamped in place and if in an exposed reach, subject to wave wash the new section should be faced with bags of sand.

c. Repair and close all flap gates on culverts and see that they are seated properly before they are covered with flood waters.

d. Ascertain that all roads to and along the levee are in a good state of repair. The Superintendent should obtain assistance from the county road forces to have all roads put in first-class condition.

e. Locate necessary tools and materials (sacks, sandbags, brush, lumber, lights, etc.), and distribute and store the same at points where active maintenance is anticipated.

f. Check and obtain repair of all telephone lines necessary for operation, obtain lists of all team forces, motorboats, motor cars, and truck transportation that can be made available.

g. Make thorough arrangements with reliable citizens of the community for the supply, transportation, subsistence, and shelter for the necessary labor.

h. Communicate directly with owners of all stock pastured on the levee and direct that all stock be removed from the levee right-of-way. Cut all fences crossing the levee that do not have gates provided.

i. Investigate all drainage ditches on the landside of the levee and open these drains when obstructions exist. Prepare to cut the necessary seep drainage ditches; however, no attempt should be made to drain the levee slope until actual seepage takes place.

Remove all dynamite and explosives of any kind from the vicinity of the levee.

8-07. Disaster Relief. It is the primary responsibility of local, State, and municipal authorities, supported by or working in connection with the American Red Cross to adopt measures for the relief of flood disaster victims. The primary mission of this District is to maintain the integrity of flood control works. However, relief measures may be undertaken by the Sacramento District in extreme cases and under compelling circumstances where local resources are clearly inadequate to cope with the situation.

8-08. General Methods of Treatment. After the above preliminary organization and precautions have been completed, the "flood-fight" itself commences. The methods of combating various defects in an earthen levee as described in the following paragraphs have been proved effective during many years of use by the Corps of Engineers. The time, manpower and materials expended on the corrective measures shown below have an equal importance as attending the details of the closure structures, and other portions of the system as described elsewhere within this manual.

8-09. Sand Boils.

a. General. A sand boil is the result of a transfer of pressure head and seepage from the river through a pervious stratum near or at the surface of the landside of the levee. This seepage under pressure

tends to push its way to the surface and actually floats the material through which it flows. If the weight of the more impervious soil overlying the pervious stratum, in which the flow under pressure is occurring is sufficient to counterbalance this pressure, no harmful effects results. When the soil stratum overlying the pervious layer fails to counterbalance the upward pressure, or when no such stratum exists, boils break through the landward surface. The sand boil may discharge relatively clear water or the discharge may contain quantities of sand and silt, depending upon the magnitude of the pressure and the size of the boil.

b. Effects of Sand boils. Sand boils can produce three distinctly different effects on the levee, as illustrated on Plate 6, Exhibit C. In Figure 1, the seepage flow develops a very definite pipe or tube under the levee which breaks out at the landward toe in the form of one or more large sand boils. Unless checked, a cavern is created under the levee, causing subsidence and subsequent overtopping. Slumping of the levee will identify this type. Figure 2 illustrates how pressurized seepage water flows under the levee without following a well-defined path and results in one or more boils outcropping at or near the landward toe. The flow from these boils tends to produce sloughing of the slope, and is evidenced by cutting and ravelling at the landward toe. Figure 3 shows a third type of effect of a sand boil, wherein numerous small boilsf many of which are scarcely noticeable, outcrop at or near the toe. While no boil may appear to be dangerous in itself, a group of boils causes flotation of the soil, erosion of the toe, and ultimate failure of the slope through sliding.

c. Method of Treatment.

(1) The accepted method of treating sand boils is to construct a ring of sandbags around the boil, building up a head of water within the ring sufficient to prevent further movement of sand and silt (see Plate 1, Exhibit C). The usual practice of ringing a sand boil is, as follows:

(a) The entire base for the sack ring is cleared of debris, in order to provide a watertight bond between the natural ground and the sack ring.

(b) The sacks are then laid in a ring around the boil, with joints staggered, and with loose earth between all sacks,

(c) The ring is carried only to a height sufficient to prevent material from being discharged. The ring should not entirely stop the flow of water, because of the probability of the excessive local pressure head causing additional ruptures of impervious strata and boils nearby.

(d) A V-shaped drain constructed of two boards, or a piece of sheet metal, is then placed near the top of the ring to carry off the water.

(2) Actual conditions at each sand boil will determine the exact dimensions of the ring. The necessary diameter and height of the ring will depend upon the size of the boil, and the flow of water from it. In general, the following considerations should govern:

(a) The base width should not be less than 1 1/2 times the contemplated height.

(b) "Weak" ground near the boil should be included within the ring, thereby preventing a break-through later.

(c) The ring should be of sufficient diameter to permit sacking operations to keep ahead of the flow of water.

(3) Where many boils are found to exist in a given area, a ring levee of sandbags should be constructed around the entire area and, if necessary, water should be pumped into the area to provide sufficient weight to counterbalance the upward pressure.

8-10. Sub-levees or Bow Levees. Sub-levees are smaller levees built to the landside of the main levee in order to form pools to reduce the effective water pressure on the landside and consequently prevent the formation of boils and movement of foundation material. If sub-levees in certain locations prove advisable, the following treatment is recommended: (a) siphons should be available for filling all sub-levees, and (b) when deemed necessary, the siphons should be put into operation and kept running until each sub-levee basin is filled. The siphons, of course, need not be run if the basin fills of its own accord from normal seepage.

8-11. Sloughs. If any sloughs develop in the levees, all soft areas should be thoroughly drained by excavating shallow ditches (see Plate No. 7, Exhibit C), after which a single layer of willow brush, if obtainable, or any small trees or limbs should be laid up and down the slope, laying the butts up and tops down, and weighted with sacks (see Plate No. 10, Exhibit C). If the slope begins to slough down, a buttress of sacks should be built on the toe and extending up the slope. The buttress on the toe should be built in the shape of a small berm. No sacks or weight other than necessary to hold the brush in place should extend up the slope more than two-thirds of the distance from toe of slope to the fault.

8-12. Wave Wash. The Superintendent and Sector Foremen should study the levee beforehand to determine the possibility of wave wash. All such reaches will be located well in advance and for use in emergency, a reserve supply of filled sacks and rolls of cotton bagging will be kept on board flats.

If the slope is well sodded, a storm of an hour's duration should cause very little damage. During periods of high wind and high water, ample labor should stand by and experienced personnel should observe where the washouts are beginning by sounding or by actually wading along the submerged slope. Sections of cotton bagging should be placed over the washed areas, as shown on Exhibit C, Plate 3. As an alternative, filled sacks should be placed in the cut in an effective manner and as soon as possible. The filled sacks should be laid in sections of sufficient length to give protection well above the anticipated rise. Bagging so laid must be thoroughly weighted down to be effective. Plate 2, Exhibit C shows a movable type of wave wash protection, also used with good results. Its advantage is that it can rapidly be built at any convenient place and easily set in place on the job.

8-13, Scours, A careful observation should be made of the riverside of the levee at all localities where a current of more than two feet per second is observed. Trouble may be looked for at the ends of old levee dikes, road-crossing ramps, old traverses, and places where pipes, sewers and other structures penetrate the levee. If any sign of scour is observed in the pits or at the ends of the dikes, soundings should be taken to observe the amount and progress of the scour. The usual method of construction to check scour in the pits, on the slopes, or at the ends of dikes will be to construct deflection dikes using brush, treetops, or lumber, driving stakes and wiring together, and filling in between with brush and filled sacks or stone.

8..14. Topping. Immediate consideration should be given the grade line of each levee section by comparison of existing grades with those shown on the drawings, "As Constructed", Exhibit B of Supplement Manuals. If any reaches show a grade below the previous highest water, emergency topping should be undertaken at once to such a grade as may be established by the District Engineer, U, S, Engineer Office, Sacramento, California, as follows:

a. Sack topping. If lumber is not available, a sack topping may be used to raise the crown of the levee about three feet. The sacks should be laid stretcherwise or along the levee for the first layer, crosswise for the second layer, and so on. Sacks should be lapped at least 1/3 either way and well mauled into place. When properly sacked and tamped, one sack will give about three to four inches of topping. If gravel is available, it should be used for the front facing so as to avoid washing out.

b. Lumber and sack topping. This is the most commonly used method of raising low reaches in emergencies. In putting on this topping, as well as other topping, a careful line of levels should be run and grade stakes set in advance. 21"x 4"x 6' stakes should then be driven on the riverside of the crown six feet apart, and 1"x 12" boards nailed to the

landside of the stakes. This wall, backed with a single tier of sacks will hold out at least one foot of water. If a second foot is necessary, the layers of sacks will have to be increased in number and reinforced. The stakes should be driven three feet in the ground, and should project out three feet, thus providing, in extreme cases, a three-foot topping if properly braced behind with sacks and earth. In some instances, it may be practicable to back up the planking with tamped earth obtained in the vicinity in lieu of the sacks shown in the drawing, Exhibit C, Plate 5.

c. Mud Box. Two types of mud box levees are shown on Plates No. 8 and 9, Exhibit C, The size of box is controlled by the conditions under which the box will function available materials, method of placing the dirt, and the time element.

d. Cut-Crown Topping. This form of work should never be resorted to except in extreme emergency, when filled sacks and lumber cannot be secured.

8-15. Caving Bank Protection. As protection against active caving of riverbanks, rock-filled cribs are very effective if properly placed. Cribs are usually 14 by 14 feet in plan by 10 to 14 inches in inside depth. The cribs are constructed on a double thickness of 1" x 4" x 14' lumber, equivalent to 2" x 4" pieces, lapped rail fence fashion at all corners and intersections. They are divided into four compartments of about equal area by two perpendicular cross walls constructed in the same manner as the side walls. The floors and covers are built up of double 1" x 4" boards spaced about 9" center-to-center. Under the floor and perpendicular to the direction of the floor boards are five equally spaced pairs of 1" x 4" boards about 3 feet center-to-center. On top of the cover, perpendicular to the direction of the cover boards, are three pairs of top boards, one over each of the side walls and one over the central division wall. All intersections are nailed with one 20d nail. The compartments are filled with rock before covering. Each wall intersection of the fabricated cribs is securely fastened by a loop of No. 9 wire. See Exhibit C, Plate 4.

8-16. Transportation. In instances where it is necessary to send equipment over roads that are impassable due to mud or sand, their passage may be provided by the use of a plank road or by means of steel or wire mats. Telephone or "walkie-talkie" communication should be provided along dangerous stretches of the levee when travel or other satisfactory means of communication cannot be maintained.

8-17. Check Lists. The check lists shown in Exhibits D and E are furnished for reproduction and use by the local interests. These lists should be used in each inspection to insure that no features of the protective system are overlooked. Items requiring repairs should be noted thereon; if items are satisfactory, they should be indicated by a check mark,

8-18. Use of Government Plant. The District Engineer is authorized (Orders and Regulations, Par. 4227,12) to use or loan Governmnt plant in sudden emergencies when life is in danger. The use of such plant is also permitted to save private property provided that no suitable private plant is available and that the plant can be spared without detriment to Government workse

CODE OF FEDERAL REGULATIONS (EXTRACT)

TITLE 33—NAVIGATION AND NAVIGABLE WATERS

Chapter II—Corps of Engineers, Department of the Army

PART 208—FLOOD CONTROL REGULATIONS

AUTHORITY: § 208.10 issued under Sec. 7, 58 Stat. 890; 33 U.S.C. 709.

§ 208.10 *Local flood protection works; maintenance and operation of structures and facilities*—(a) *General*. (1) The structures and facilities constructed by the United States for local flood protection shall be continuously maintained in such a manner and operated at such times and for such periods as may be necessary to obtain the maximum benefits.

(2) The State, political subdivision thereof, or other responsible local agency, which furnished assurance that it will maintain and operate flood control works in accordance with regulations prescribed by the Secretary of the Army, as required by law, shall appoint a permanent committee consisting of or headed by an official hereinafter called the "Superintendent," who shall be responsible for the development and maintenance of, and directly in charge of, an organization responsible for the efficient operation and maintenance of all of the structures and facilities during flood periods and for continuous inspection and maintenance of the project works during periods of low water, all without cost to the United States.

(3) A reserve supply of materials needed during a flood emergency shall be kept on hand at all times.

(4) No encroachment or trespass which will adversely affect the efficient operation or maintenance of the project works shall be permitted upon the rights-of-way for the protective facilities.

(5) No improvement shall be passed over, under, or through the walls, levees, improved channels or floodways, nor shall any excavation or construction be permitted within the limits of the project right-of-way, nor shall any change be made in any feature of the works without prior determination by the District Engineer of the Department of the Army or his authorized representative that such improvement, excavation, construction, or alteration will not adversely affect the functioning of the protective facilities. Such improvements or alterations as may be found to be desirable and permissible under the above determination shall be constructed in accordance with standard engineering practice. Advice regarding the effect of proposed improvements or alterations on the functioning of the project and information concerning methods of construction acceptable under standard engineering practice shall be obtained from the District Engineer or, if otherwise obtained, shall be submitted for his approval. Drawings or prints showing such improvements or alterations as finally constructed shall be furnished to the District Engineer after completion of the work.

(6) It shall be the duty of the Superintendent to submit a semiannual report to the District Engineer covering inspection, maintenance, and operation of the protective works.

(7) The District Engineer or his authorized representatives shall have ac-

cess at all times to all portions of the protective works.

(8) Maintenance measures or repairs which the District Engineer deems necessary shall be promptly taken or made.

(9) Appropriate measures shall be taken by local authorities to insure that the activities of all local organizations operating public or private facilities connected with the protective works are coordinated with those of the Superintendent's organization during flood periods.

(10) The Department of the Army will furnish local interests with an Operation and Maintenance Manual for each completed project, or separate useful part thereof, to assist them in carrying out their obligations under this part.

(b) *Levees*—(1) *Maintenance*. The Superintendent shall provide at all times such maintenance as may be required to insure serviceability of the structures in time of flood. Measures shall be taken to promote the growth of sod, exterminate burrowing animals, and to provide for routine mowing of the grass and weeds, removal of wild growth and drift deposits, and repair of damage caused by erosion or other forces. Where practicable, measures shall be taken to retard bank erosion by planting of willows or other suitable growth on areas riverward of the levees. Periodic inspections shall be made by the Superintendent to insure that the above maintenance measures are being effectively carried out and, further, to be certain that:

(i) No unusual settlement, sloughing, or material loss of grade or levee cross section has taken place;

(ii) No caving has occurred on either the land side or the river side of the levee which might affect the stability of the levee section;

(iii) No seepage, saturated areas, or sand boils are occurring;

(iv) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged;

(v) Drains through the levees and gates on said drains are in good working condition;

(vi) No revetment work or riprap has been displaced, washed out, or removed;

(vii) No action is being taken, such as burning grass and weeds during inappropriate seasons, which will retard or destroy the growth of sod;

(viii) Access roads to and on the levee are being properly maintained;

(ix) Cattle guards and gates are in good condition;

(x) Crown of levee is shaped so as to drain readily, and roadway thereon, if any, is well shaped and maintained;

(xi) There is no unauthorized grazing or vehicular traffic on the levees;

(xii) Encroachments are not being made on the levee right-of-way which might endanger the structure or hinder its proper and efficient functioning during times of emergency.

Such inspections shall be made immediately prior to the beginning of the flood season; immediately following each major high water period, and otherwise at intervals not exceeding 90 days; and such intermediate times as may be necessary to insure the best possible care of the levee. Immediate steps will be taken to correct dangerous conditions disclosed by such inspections. Regular maintenance repair measures shall be accom-

plished during the appropriate season as scheduled by the Superintendent.

(2) *Operation*. During flood periods the levee shall be patrolled continuously to locate possible sand boils or unusual wetness of the landward slope and to be certain that:

(i) There are no indications of slides or sloughs developing;

(ii) Wave wash or scouring action is not occurring;

(iii) No low reaches of levee exist which may be overtopped;

(iv) No other conditions exist which might endanger the structure.

Appropriate advance measures will be taken to insure the availability of adequate labor and materials to meet all contingencies. Immediate steps will be taken to control any condition which endangers the levee and to repair the damaged section.

(c) *Flood walls*.—(1) *Maintenance*. Periodic inspections shall be made by the Superintendent to be certain that:

(i) No seepage, saturated areas, or sand boils are occurring;

(ii) No undue settlement has occurred which affects the stability of the wall or its water tightness;

(iii) No trees exist, the roots of which might extend under the wall and offer accelerated seepage paths;

(iv) The concrete has not undergone cracking, chipping, or breaking to an extent which might affect the stability of the wall or its water tightness;

(v) There are no encroachments upon the right-of-way which might endanger the structure or hinder its functioning in time of flood;

(vi) Care is being exercised to prevent accumulation of trash and debris adjacent to walls, and to insure that no fires are being built near them;

(vii) No bank caving conditions exist riverward of the wall which might endanger its stability;

(viii) Toe drainage systems and pressure relief wells are in good working condition, and that such facilities are not becoming clogged.

Such inspections shall be made immediately prior to the beginning of the flood season, immediately following each major high water period, and otherwise at intervals not exceeding 90 days. Measures to eliminate encroachments and effect repairs found necessary by such inspections shall be undertaken immediately. All repairs shall be accomplished by methods acceptable in standard engineering practice.

(2) *Operation*. Continuous patrol of the wall shall be maintained during flood periods to locate possible leakage at monolith joints or seepage underneath the wall. Floating plant or boats will not be allowed to lie against or tie up to the wall. Should it become necessary during a flood emergency to pass anchor cables over the wall, adequate measures shall be taken to protect the concrete and construction joints. Immediate steps shall be taken to correct any condition which endangers the stability of the wall.

(d) *Drainage structures*—(1) *Maintenance*. Adequate measures shall be taken to insure that inlet and outlet channels are kept open and that trash, drift, or debris is not allowed to accumulate near drainage structures. Flap gates and manually operated gates and valves on drainage structures shall be examined, oiled, and trial operated at least once

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every 90 days. Where drainage structures are provided with stop log or other emergency closures, the condition of the equipment and its housing shall be inspected regularly and a trial installation of the emergency closure shall be made at least once each year. Periodic inspections shall be made by the Superintendent to be certain that:

(i) Pipes, gates, operating mechanism, riprap, and headwalls are in good condition;

(ii) Inlet and outlet channels are open;

(iii) Care is being exercised to prevent the accumulation of trash and debris near the structures and that no fires are being built near bituminous coated pipes;

(iv) Erosion is not occurring adjacent to the structure which might endanger its water tightness or stability.

Immediate steps will be taken to repair damage, replace missing or broken parts, or remedy adverse conditions disclosed by such inspections.

(2) *Operation.* Whenever high water conditions impend, all gates will be inspected a short time before water reaches the invert of the pipe and any object which might prevent closure of the gate shall be removed. Automatic gates shall be closely observed until it has been ascertained that they are securely closed. Manually operated gates and valves shall be closed as necessary to prevent inflow of flood water. All drainage structures in levees shall be inspected frequently during floods to ascertain whether seepage is taking place along the lines of their contact with the embankment. Immediate steps shall be taken to correct any adverse condition.

(e) *Closure structures—(1) Maintenance.* Closure structures for traffic openings shall be inspected by the Superintendent every 90 days to be certain that:

(i) No parts are missing;

(ii) Metal parts are adequately covered with paint;

(iii) All movable parts are in satisfactory working order;

(iv) Proper closure can be made promptly when necessary;

(v) Sufficient materials are on hand for the erection of sand bag closures and that the location of such materials will be readily accessible in times of emergency.

Tools and parts shall not be removed for other use. Trial erections of one or more closure structures shall be made once each year, alternating the structures chosen so that each gate will be erected at least once in each 3-year period. Trial erection of all closure structures shall be made whenever a change is made in key operating personnel. Where railroad operation makes trial erection of a closure structure infeasible, rigorous inspection and drill of operating personnel may be substituted therefor. Trial erection of sand bag closures is not required. Closure materials will be carefully checked prior to and following flood periods, and damaged or missing parts shall be repaired or replaced immediately.

(2) *Operation.* Erection of each movable closure shall be started in sufficient time to permit completion before flood waters reach the top of the structure sill. Information regarding the proper method of erecting each individual closure structure, together with an estimate

of the time required by an experienced crew to complete its erection will be given in the Operation and Maintenance Manual which will be furnished local interests upon completion of the project. Closure structures will be inspected frequently during flood periods to ascertain that no undue leakage is occurring and that drains provided to care for ordinary leakage are functioning properly. Boats or floating plant shall not be allowed to tie up to closure structures or to discharge passengers or cargo over them.

(f) *Pumping plants—(1) Maintenance.* Pumping plants shall be inspected by the Superintendent at intervals not to exceed 30 days during flood seasons and 90 days during off-flood seasons to insure that all equipment is in order for instant use. At regular intervals, proper measures shall be taken to provide for cleaning plant, buildings, and equipment, repainting as necessary, and lubricating all machinery. Adequate supplies of lubricants for all types of machines, fuel for gasoline or diesel powered equipment, and flash lights or lanterns for emergency lighting shall be kept on hand at all times. Telephone service shall be maintained at pumping plants. All equipment, including switch gear, transformers, motors, pumps, valves, and gates shall be trial operated and checked at least once every 90 days. Megger tests of all insulation shall be made whenever wiring has been subjected to undue dampness and otherwise at intervals not to exceed one year. A record shall be kept showing the results of such tests. Wiring disclosed to be in an unsatisfactory condition by such tests shall be brought to a satisfactory condition or shall be promptly replaced. Diesel and gasoline engines shall be started at such intervals and allowed to run for such length of time as may be necessary to insure their serviceability in times of emergency. Only skilled electricians and mechanics shall be employed on tests and repairs. Operating personnel for the plant shall be present during tests. Any equipment removed from the station for repair or replacement shall be returned or replaced as soon as practicable and shall be trial operated after reinstallation. Repairs requiring removal of equipment from the plant shall be made during off-flood seasons insofar as practicable.

(2) *Operation.* Competent operators shall be on duty at pumping plants whenever it appears that necessity for pump operation is imminent. The operator shall thoroughly inspect, trial operate, and place in readiness all plant equipment. The operator shall be familiar with the equipment manufacturers' instructions and drawings and with the "Operating Instructions" for each station. The equipment shall be operated in accordance with the above-mentioned "Operating Instructions" and care shall be exercised that proper lubrication is being supplied all equipment, and that no overheating, undue vibration or noise is occurring. Immediately upon final recession of flood waters, the pumping station shall be thoroughly cleaned, pump house sumps flushed, and equipment thoroughly inspected, oiled and greased. A record or log of pumping plant operation shall be kept for each station, a copy of which shall be furnished the District Engineer following each flood.

(g) *Channels and floodways—(1) Maintenance.* Periodic inspections of improved channels and floodways shall be made by the Superintendent to be certain that:

(i) The channel or floodway is clear of debris, weeds, and wild growth;

(ii) The channel or floodway is not being restricted by the depositing of waste materials, building of unauthorized structures or other encroachments;

(iii) The capacity of the channel or floodway is not being reduced by the formation of shoals;

(iv) Banks are not being damaged by rain or wave wash, and that no sloughing of banks has occurred;

(v) Riprap sections and deflection dikes and walls are in good condition;

(vi) Approach and egress channels adjacent to the improved channel or floodway are sufficiently clear of obstructions and debris to permit proper functioning of the project works.

Such inspections shall be made prior to the beginning of the flood season and otherwise at intervals not to exceed 90 days. Immediate steps will be taken to remedy any adverse conditions disclosed by such inspections. Measures will be taken by the Superintendent to promote the growth of grass on bank slopes and earth deflection dikes. The Superintendent shall provide for periodic repair and cleaning of debris basins, check dams, and related structures as may be necessary.

(2) *Operation.* Both banks of the channel shall be patrolled during periods of high water, and measures shall be taken to protect those reaches being attacked by the current or by wave wash. Appropriate measures shall be taken to prevent the formation of jams of ice or debris. Large objects which become lodged against the bank shall be removed. The improved channel or floodway shall be thoroughly inspected immediately following each major high water period. As soon as practicable thereafter, all snags and other debris shall be removed and all damage to banks, riprap, deflection dikes and walls, drainage outlets, or other flood control structures repaired.

(h) *Miscellaneous facilities—(1) Maintenance.* Miscellaneous structures and facilities constructed as a part of the protective works and other structures and facilities which function as a part of, or affect the efficient functioning of the protective works, shall be periodically inspected by the Superintendent and appropriate maintenance measures taken. Damaged or unserviceable parts shall be repaired or replaced without delay. Areas used for ponding in connection with pumping plants or for temporary storage of interior run-off during flood periods shall not be allowed to become filled with silt, debris, or dumped material. The Superintendent shall take proper steps to prevent restriction of bridge openings and, where practicable, shall provide for temporary raising during floods of bridges which restrict channel capacities during high flows.

(2) *Operation.* Miscellaneous facilities shall be operated to prevent or reduce flooding during periods of high water. Those facilities constructed as a part of the protective works shall not be used for purposes other than flood protection without approval of the District Engineer unless designed therefor. (Sec. 3, 49 Stat. 1571, as amended; 33 U.S.C. 701C) [9 F.R. 9999, Aug. 17, 1944; 9 F.R. 10203, Aug. 22, 1944]

EXHIBIT B
"AS CONSTRUCTED" DRAWINGS
(See Supplement Manuals)

EXHIBIT B
Unattached

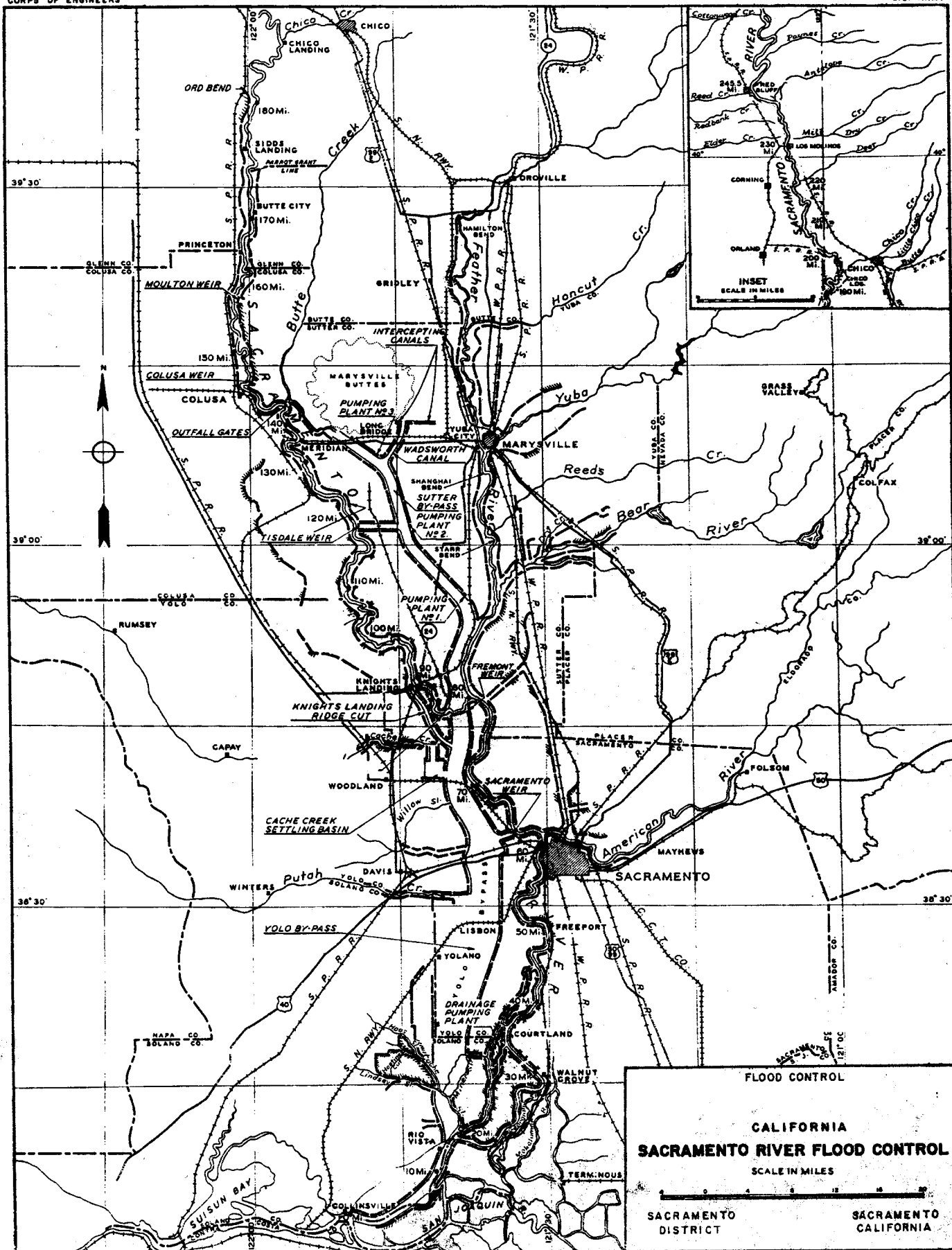
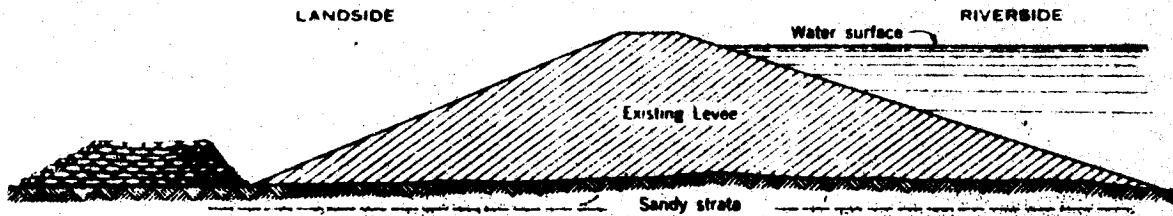


EXHIBIT C
PLATES OF SUGGESTED FIGHTING METHODS



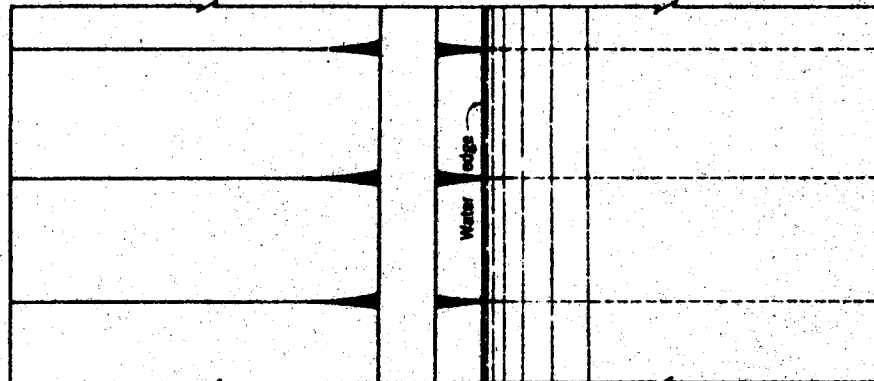
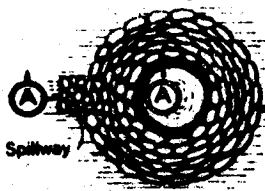
Note:

Bottom width to be no less than $1\frac{1}{2}$ times height.
Be sure to clear sand discharge.
Tie into levee if boil is near toe.

ELEVATION



SECTION A-A



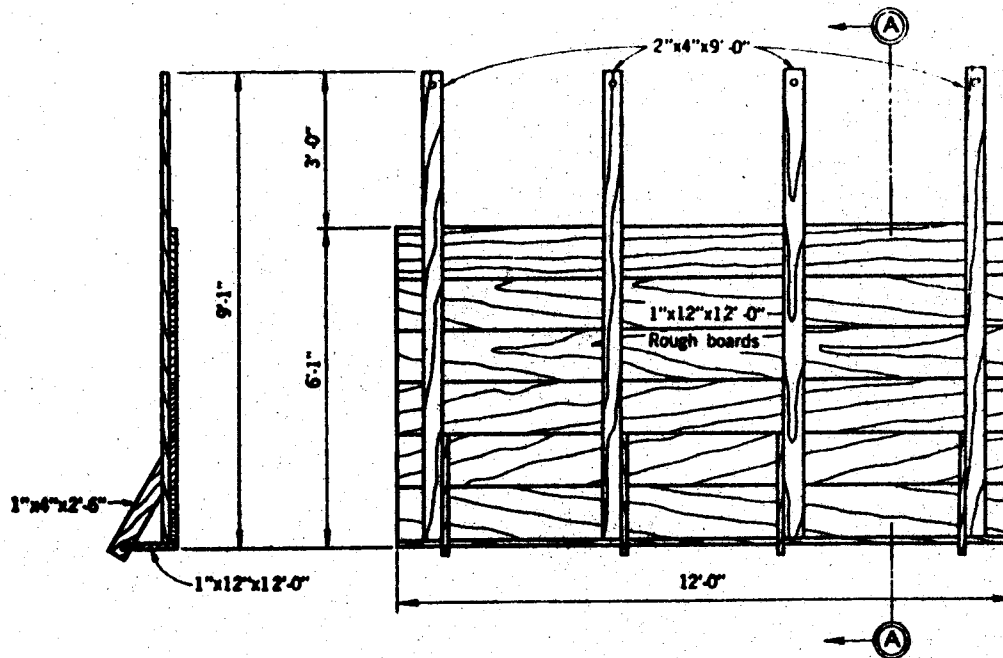
PLAN

Note:

Do not sack boil which does not put out material.
Height of sack loop or ring should be only sufficient to create enough head to slow down flow through boil so that no more material is displaced and boil runs clear.
Never attempt to completely stop flow through boil.

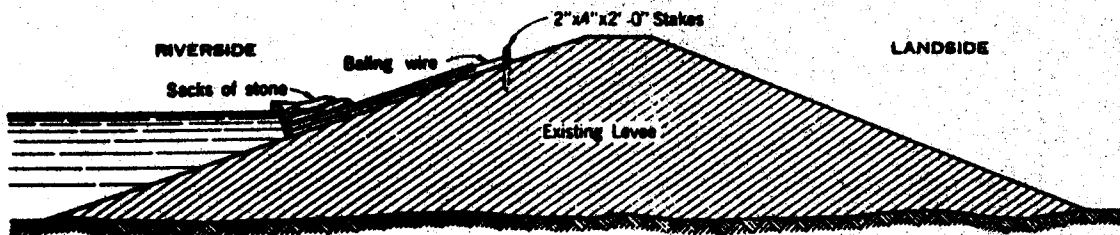
CONTROL OF SAND BOILS

U.S. ENGINEER OFFICE, SACRAMENTO, CALIF.



SECTION A-A

PLAN

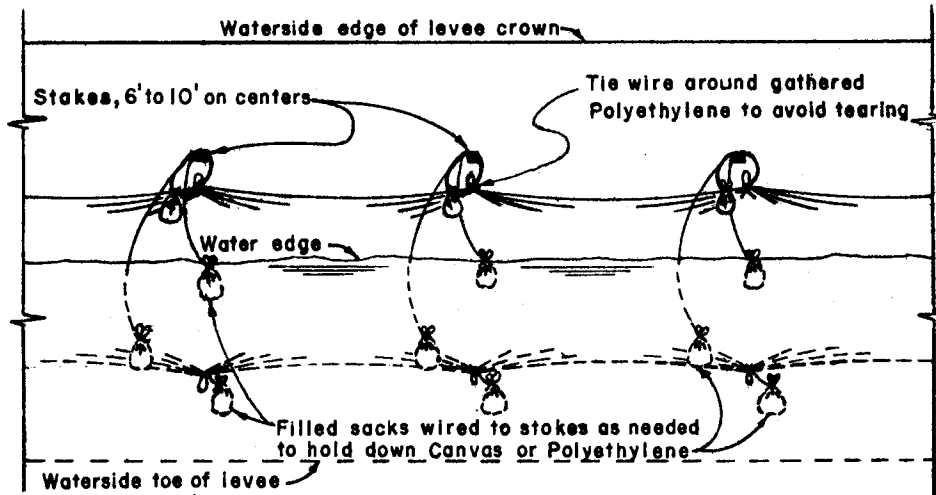
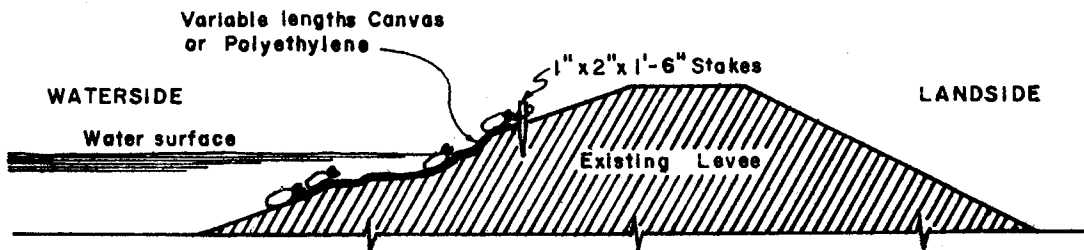


SECTION

BILL OF MATERIAL FOR 100 FEET	
LUMBER	
56 pieces	1"x12"x12'-0"
32 pieces	1"x4"x2'-6"
32 pieces	2"x4"x9'-0"
• 32 pieces	2"x4"x2'-0"
•	(Sharpened)
WIRE	
200'	baling wire
NAILS	
4 1/2 lbs.	8d nails

MOVABLE WAVE WASH PROTECTION

U. S. ENGINEER OFFICE, SACRAMENTO, CALIF.

P L A NS E C T I O NNOTE:

Use Polyethylene sheets, preferably 16' to 20' wide available in std. 100' long rolls, approx. 6 mil thickness, or canvas as available. Lay chosen length of Polyethylene sheeting or canvas parallel with levee slope, tie upper edge to stakes, tie sacks to bottom edge. Crew will then toss all bottom sacks over damaged slope at the same time to avoid tearing. Intermediate filled sacks will be immediately placed to hold down canvas or plastic. HAVE ALL ITEMS PREPARED BEFOREHAND.

**MATERIAL REQUIRED FOR 100
LINEAR FEET OF LEVEE**

LUMBER

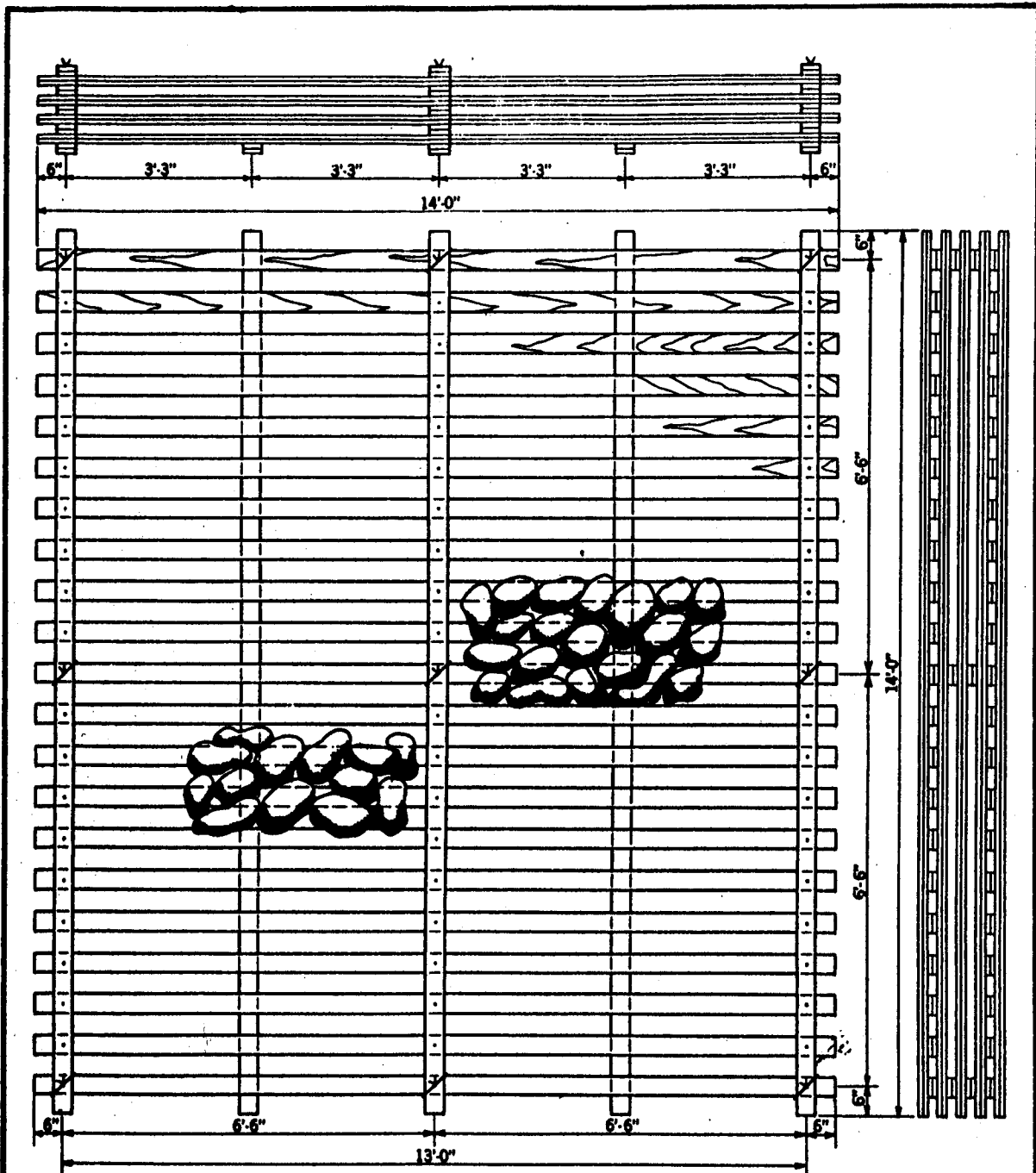
- 90 Stakes 1"x2"x1'-6"
- (Sharpened)

SANDBAGS

120 sandbags
Canvas or Polyethylene
sheeting as required

WAVE WASH PROTECTION

US Army Engineer District
Sacramento, California

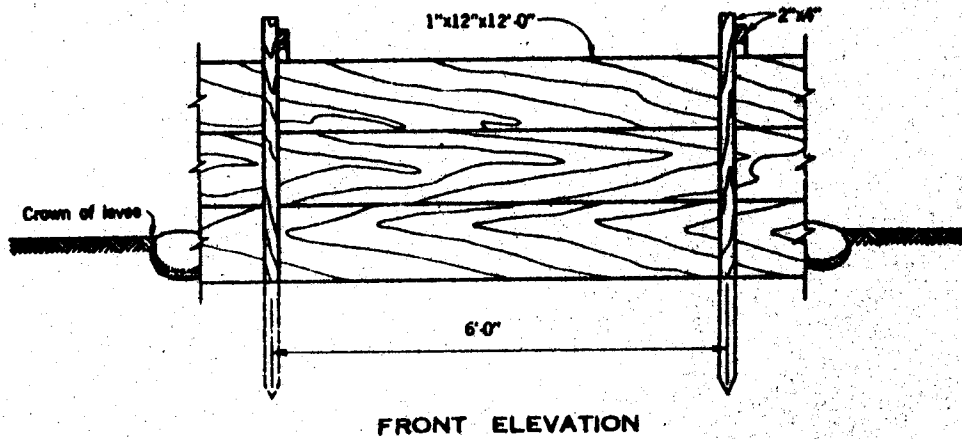
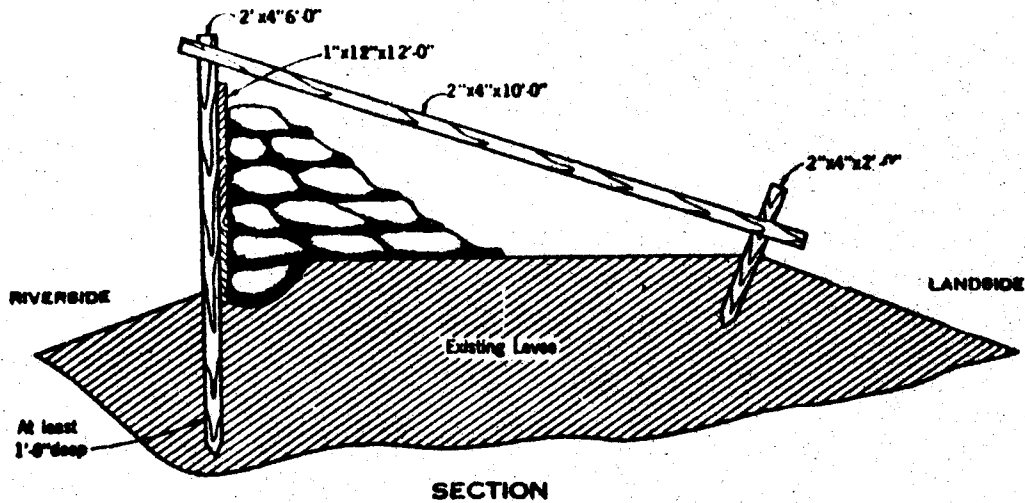
**Note:**

Crib constructed of double thickness of 1"x4"x14'-0" lumber. Nail all intersections with 1-20d nail. Each intersection of walls securely fastened by a loop of No. 9 wire, tightly twisted.

BILL OF MATERIAL FOR ONE CRIB 13'-0"	
LUMBER	
130 pieces	1"x4"x14'-0"
WIRE	
30'	No. 9 wire
NAILS	
12½ lbs.	20d nails

CAVING BANK PROTECTION

U. S. ENGINEER OFFICE, SACRAMENTO, CALIF.



BILL OF MATERIAL FOR 100 LINEAR FEET OF LEVEE	
LUMBER	
25 pieces	1" x 12" x 12' 0"
17 pieces	2" x 4" x 10' 0"
• 17 pieces	2" x 4" x 6' 0"
• 17 pieces	2" x 4" x 2' 0"
•	(Sharpened)
NAILS	
1 lb.	8d nails
2 lbs.	16d nails
SANDBAGS	
1100	bags

FLOOD CONTROL PROJECT

LUMBER AND SACK TOPPING

U. S. ENGINEER OFFICE, SACRAMENTO, CALIF.

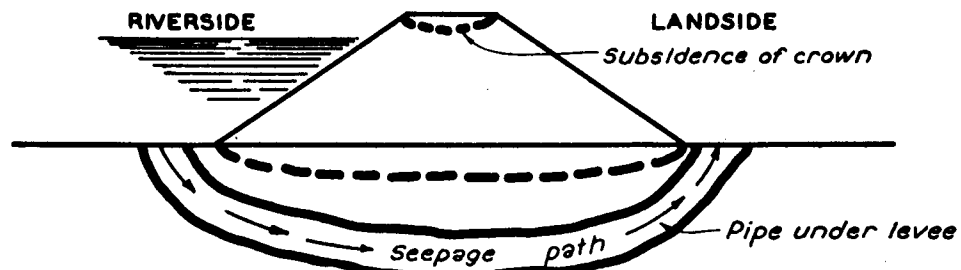
**DEVELOPMENT OF PIPE UNDER LEVEE**

FIG. 1

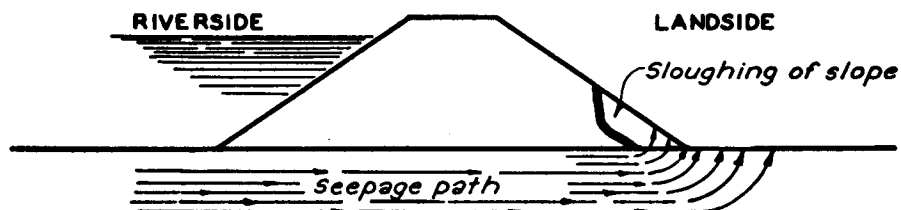
**SLOUGHING OF LANDSIDE SLOPE DUE TO
RAVELLING AND UNDERCUTTING OF TOE**

FIG. 2

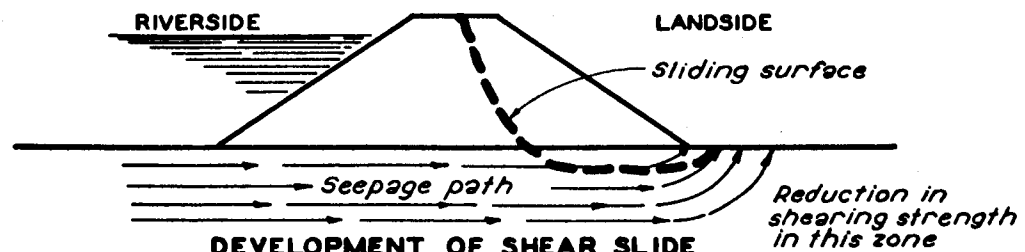
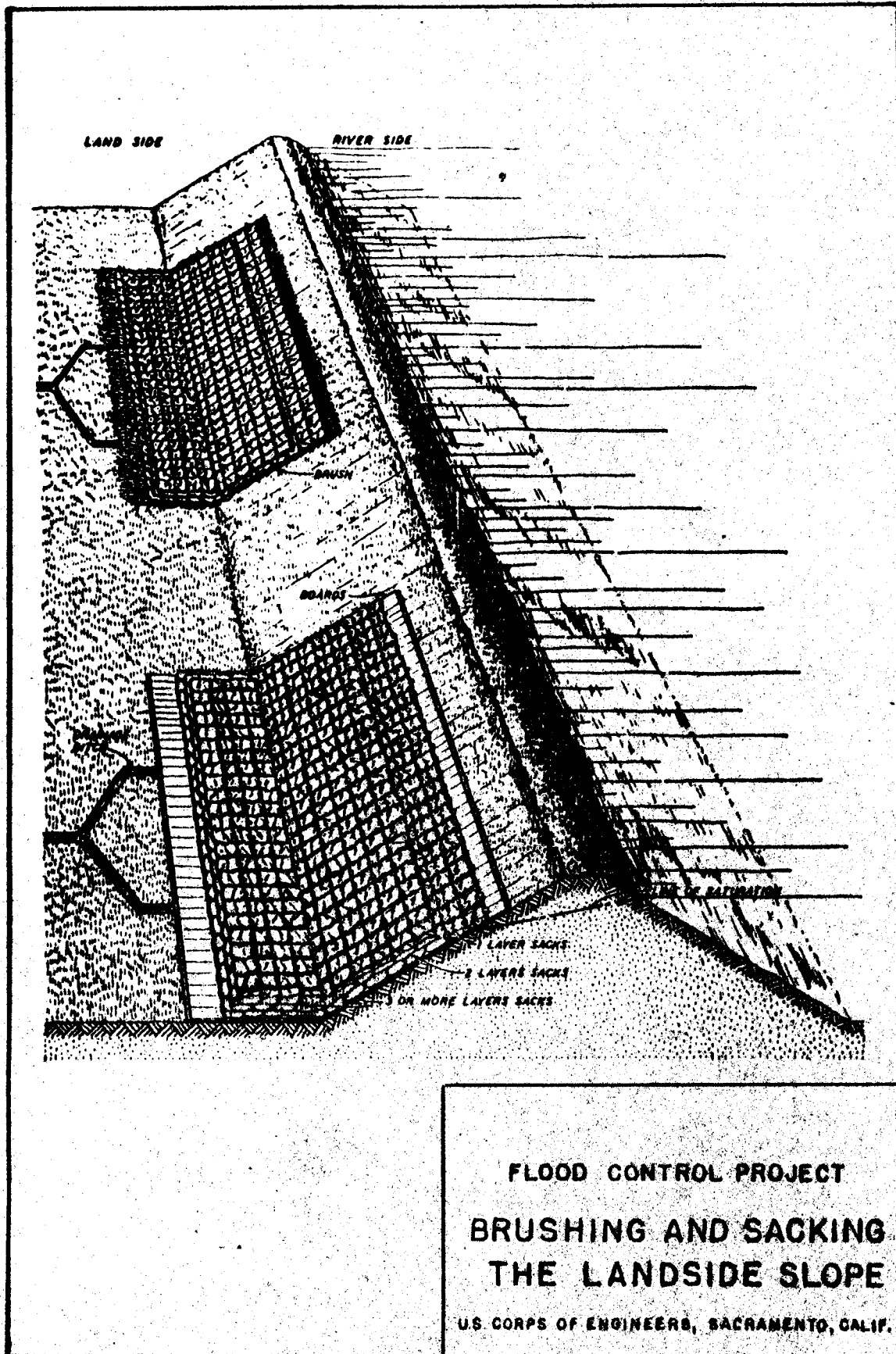
**DEVELOPMENT OF SHEAR SLIDE**

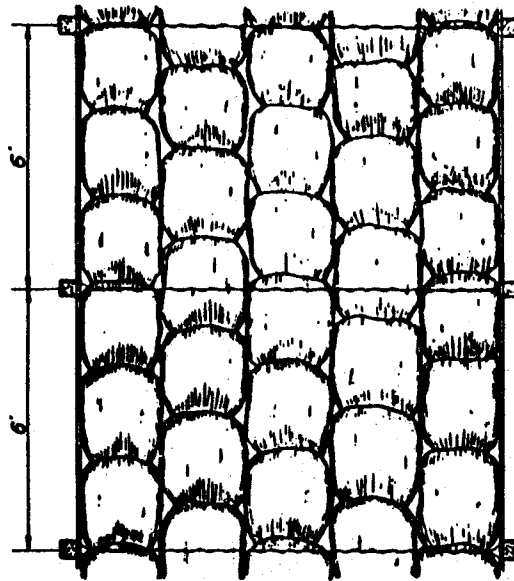
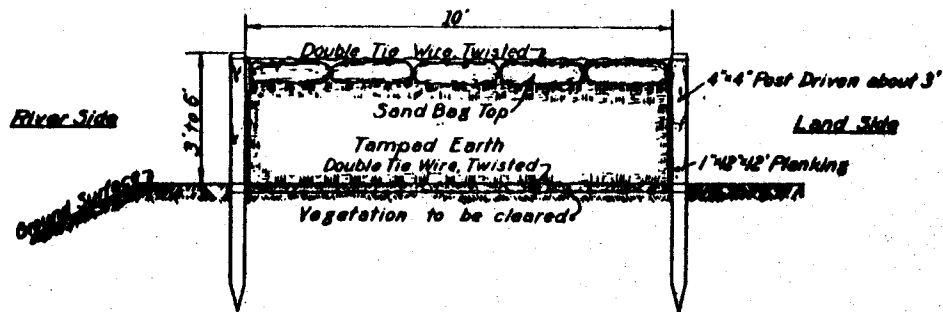
FIG. 3

SACRAMENTO RIVER, CALIFORNIA
FLOOD CONTROL PROJECT

EFFECTS OF SAND BOILS ON LEVEE

U.S. CORPS OF ENGINEERS, SACRAMENTO, CALIF.

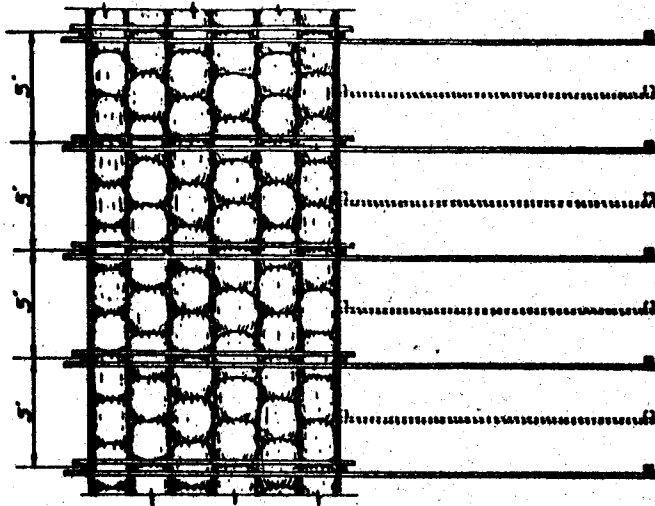


PLANEND ELEVATION

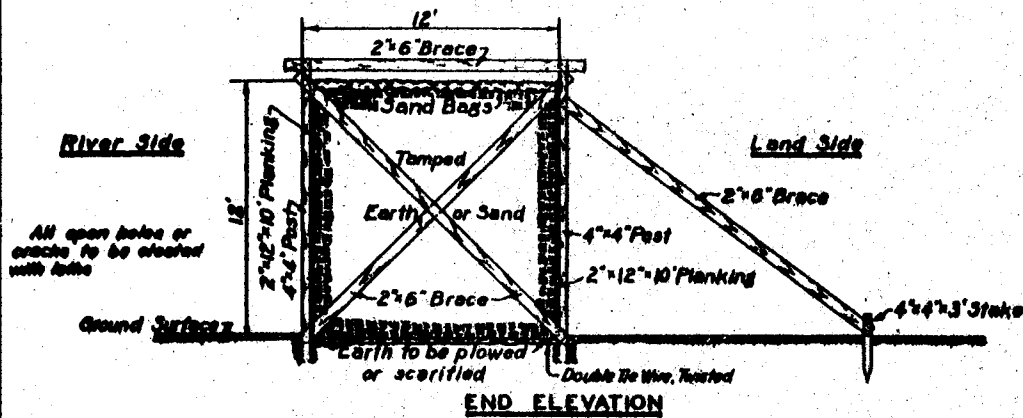
MATERIAL REQUIRED FOR 100 LINEAR FEET OF LEVEE		
4 FT HIGH	5 FT HIGH	6 FT HIGH
34 pieces 4"x4"x7' (sharpened) 1122	34 pieces 4"x4"x8' (sharpened) 1371	34 pieces 4"x4"x9' (sharpened) 1608
47 pieces 1"x12"x12' board feet	64 pieces 1"x12"x12' board feet	100 pieces 1"x12"x12' board feet
25 lbs. wire #12 gage	25 lbs. wire #12 gage	25 lbs. wire #12 gage
13 lbs. 10d nails	15 lbs. 10d nails	17 lbs. 10d nails
600 sand bags	600 sand bags	600 sand bags
148 cu. yds. earth	185 cu. yds. earth	222 cu. yds. earth

FLOOD CONTROL PROJECT
3-6 FT. MUD BOX LEVEE
CONSTRUCTION DETAILS

U.S. CORPS OF ENGINEERS, SACRAMENTO, CALIF.



PLAN



MATERIAL REQUIRED FOR 100 LINEAR FEET OF LEVEE			
LUMBER	SAND BAGS	NAILS	EARTH or SAND
40 Posts 4"x4"	700	120 lbs. 20d	534 cu yds.
200 Posts 2"x6"		4 lbs. 3d wire	
20 Posts 2"x6"		WIRE	
40 Posts 2"x6"		20 lbs. 12 gage	
10 2x6 Straps 4"x4"			
3 2x6x10 Joists			

Total Lumber 6387 board feet.

ADDITIONAL MATERIAL FOR BRACING BACK SIDE IN BETWEEN BENTS			
LUMBER	SAND BAGS	NAILS	EARTH or SAND
20 Posts 4"x4"		6 lbs. - 20d	
20 Braces 2"x6"			
20 Stakes 4"x4"			

Total Lumber @ 1 board foot

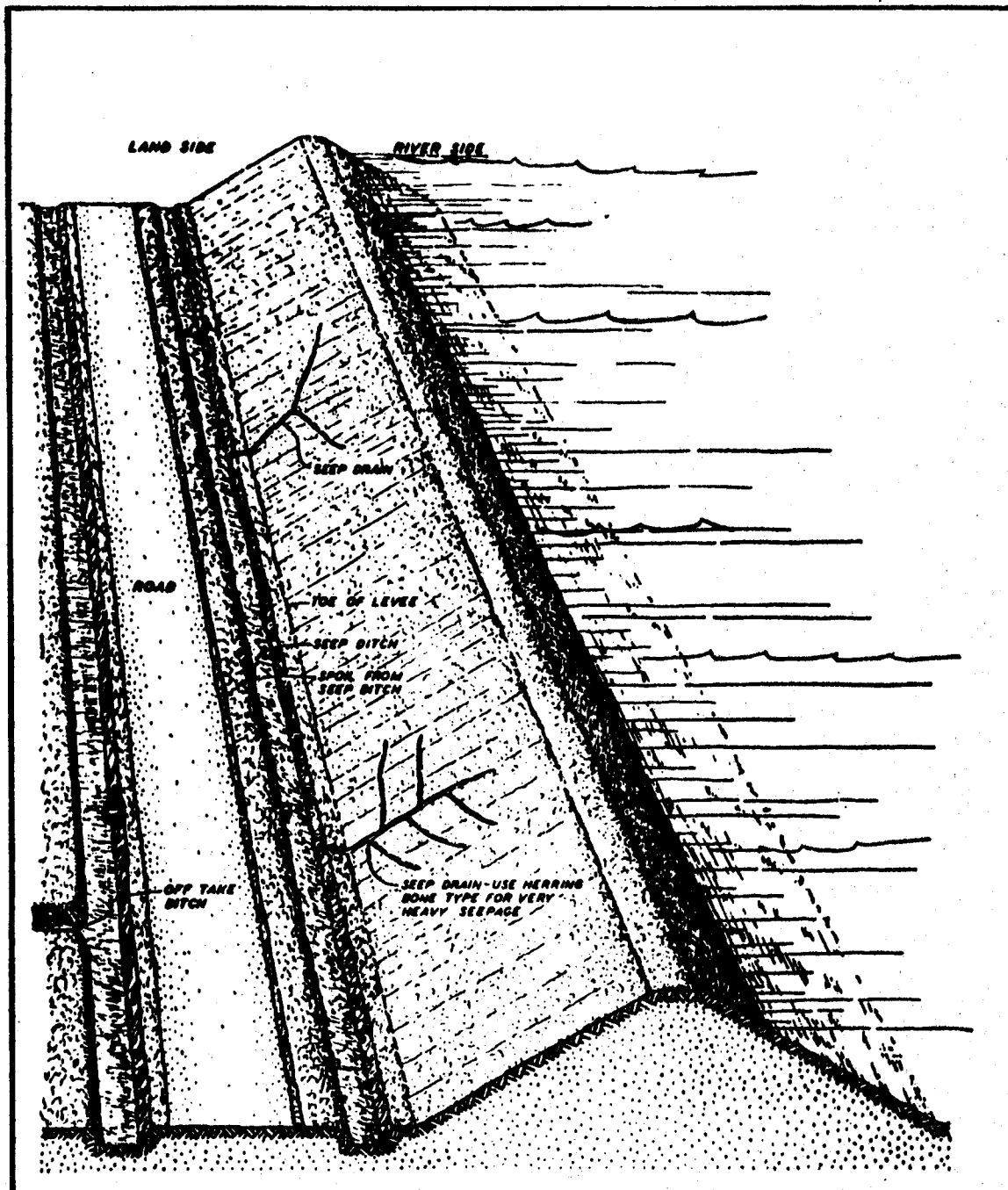
Sharpened

SACRAMENTO RIVER AND MAJOR AND MINOR TRIBUTARIES

FLOOD CONTROL PROJECT

MUD BOX BULKHEAD LEVEE CONSTRUCTION DETAILS

U.S. CORPS OF ENGINEERS, SACRAMENTO, CALIF.



FLOOD CONTROL PROJECT

METHOD OF

DRAINING LEVEE SLOPE

U.S. CORPS OF ENGINEERS, SACRAMENTO, CALIF.

CHECK LIST NO. 1

LEVEE INSPECTION REPORT

Date _____

Inspected by _____

Report number of places requiring maintenance work opposite each item listed below. A separate report should be submitted describing the necessary maintenance work for each location.

Reference Manual No. _____

Item No.	Description	Number of Places
1.	Settlement, sloughing, or loss of grade.....	_____
2.	Caving, (either side of levee).....	_____
3.	Seepage, saturation.....	_____
4.	Rip-rap	_____
5.	Sod	_____
6.	Access roads and road ramps	_____
7.	Cattle guards and gates	_____
8.	Crown of Levee	_____
9.	Unauthorized grazing or traffic	_____
10.	Unauthorized encroachment on rights-of-way	_____
11.	Unauthorized excavation and loose backfill	_____
12.	Accumulations of drift, trash or debris	_____
13.	Weed or undesirable vegetation	_____
14.	Miscellaneous pipe crossings	_____
15.	Inappropriate burning of grass	_____
16.	Other items not included above	_____

Inspected by _____

EXHIBIT E

CHANNEL AND STUCTURES

(See Supplement Manuals)

EXHIBIT F
LETTER OF ACCEPTANCE
BY STATE RECLAMATION BOARD
(See Supplement Manuals)

EXHIBIT F
Unattached

EXHIBIT G

SUGGESTED SEMI - ANNUAL REPORT FORM
(See Supplement Manuals)

EXHIBIT G
Unattached

Operations and Maintenance Manual Template

SACRAMENTO RIVER BANK PROTECTION PROJECT PHASE II, 80,000 LINEAR FEET

Prepared for:
**U.S. Army Corps of Engineers
Sacramento District**



January 25, 2012

Prepared by:
HDR Engineering, Inc.



2365 Iron Point Road, Suite 300
Folsom, CA 95630

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1.0 Introduction

1.1 Purpose

This information report and template is an appendix to the Engineering Document Report, Sacramento River Bank Protection Project (SRBPP) (currently in preparation). This template provides information on revising and adding new material to the existing operations and maintenance (O&M) manuals to take into account new bank protection along the Sacramento River Flood Control Project (SRFCP) that is constructed under the SRBPP authority.

1.2 Use of Operations and Maintenance Manual Template

This template has been developed to be used as guidance for future SRBPP O&M manual preparers and provides general information to Corps of Engineers (Corps) personnel and local interests. This manual template is meant to be used as a general guide; it may be considered a template that can facilitate O&M manual preparation. The use of this as a template will encourage preserving consistency among the O&M manuals as they are individually revised. Future O&M manual revisions and additions will occur as bank protection becomes known and is constructed.

1.3 Background

Operation and maintenance manuals are often prepared to inform local interests in the O&M of levees and other flood risk management facilities. Engineering Regulation ER 1150-2-301 Local Cooperation Policies and Procedures provides for the preparation of O&M manuals. Manuals are described as follows in the regulation:

- ◆ The purpose of the O&M manual is to assist the responsible authorities in carrying out their obligations through provision of information and advice with respect to the operation and maintenance requirements of the project.
- ◆ Manuals will be prepared sufficiently in advance of completion of the project to ensure their readiness for transmission to local interest at the time of formal transfer of the project from the Corps to the non-Federal sponsor.

Since bank protection constitutes modifications to the SRFCP, it has been the practice to modify and amend the SRFCP O&M manuals. This practice avoids redundancy and confusion, and is expected to continue with the SRBPP Phase II 80,000 LF as well.

2.0 Sacramento River Flood Control Project Manuals

2.1 SRFCP O&M Manual organization

There is one overarching manual for the SRFCP, and a series of manuals covering specific levee units in more detail. The overarching manual is the Standard Operations and Maintenance Manual, referred to as the “Standard Manual.” The Standard Manual is dated

May 1955. It has an addendum dated April 1995 and a supplement to the addendum dated March 1996.

For each levee unit (defined below) a Supplemental Operations and Maintenance Manual (referred to herein as “Supplemental Manual”) is prepared. **Figure 1** shows an example cover page of a Supplemental Manual. When the Sacramento Bank Protection Project constructs bank protection, amendments and revisions are made to the Supplemental Manual that covers the unit in which the construction is located. No amendment is made to the Standard Manual.

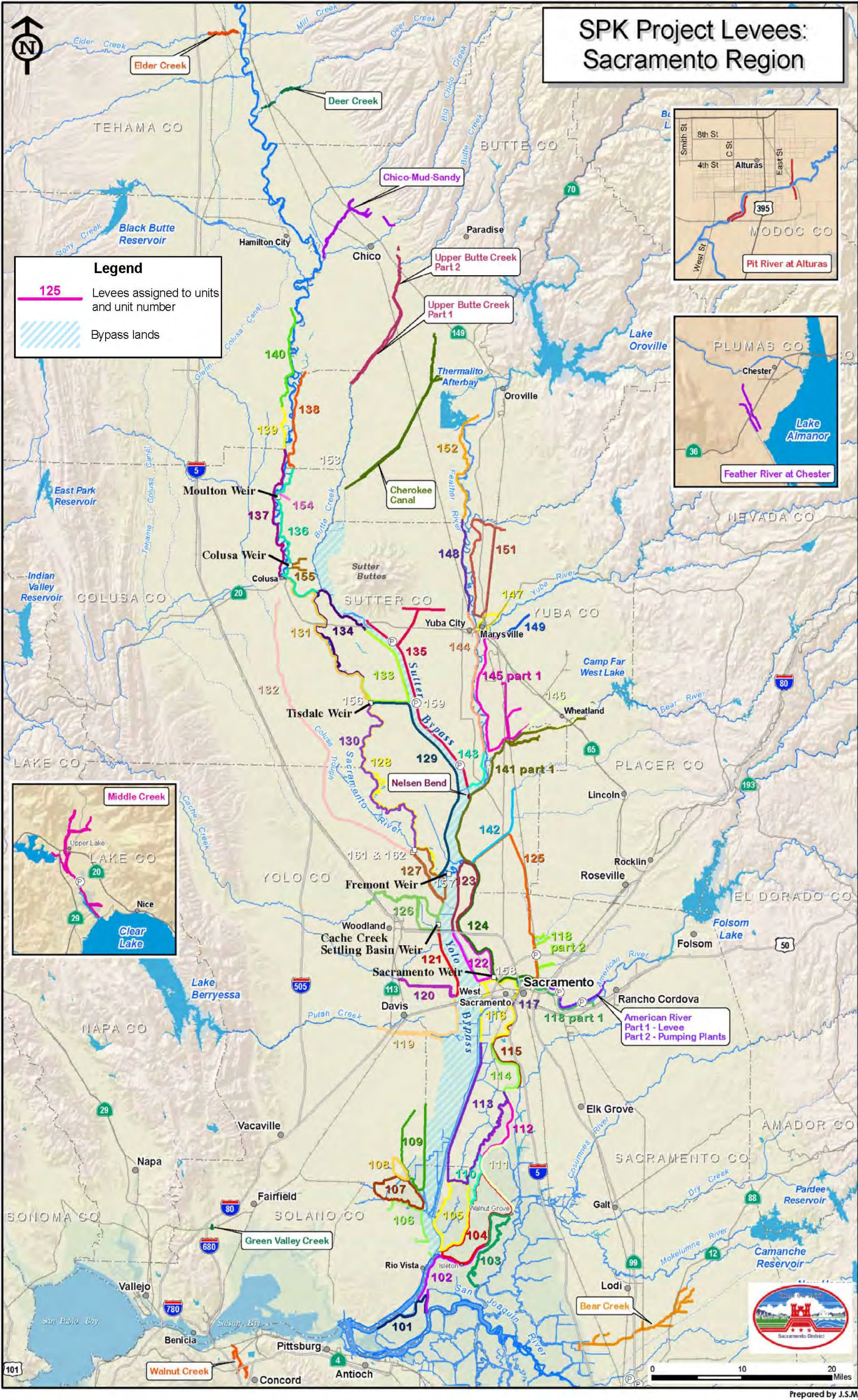
The SRFCP is subdivided into maintenance units generally corresponding to levees associated with a protected floodplain or reclaimed land. The units are numbered starting from Unit 101, Sherman Island levees, near the mouth of the Sacramento River. The units are numbered sequentially, generally south to north, up to Unit 165. The units cover both the Sacramento River and its tributaries and distributaries. **Figure 2** is a map showing the levee maintenance units locations along the SRFCP.

Figure 1 - Cover to Sample Supplemental Manual



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Figure 2 - SRFP Maintenance Unit Map



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3.0 Amendments and Revisions

3.1 Typical Amendments and Revisions

Changes to the Supplemental Manuals are completed to document and identify new bank protection features, including engineered structures and vegetation plantings. In most cases O&M practices will remain the same as before bank protection. Addition of special advice or instructions due to the new construction may be appropriate if it differs from the O&M practice already in place.

The following is a list of new information that is typically added to Supplemental Manuals when bank protection is constructed:

- ◆ Location and extent of construction, including left or right bank, river miles, and latitude and longitude coordinates (optionally may also provide northing and easting coordinates)
- ◆ References to “as constructed” or “as-built” drawings, including drawing file numbers
- ◆ Construction contract information, including contractor and contract number
- ◆ Pertinent correspondence, including formal project transfer and project acceptance
- ◆ Identification and location of construction drawings
- ◆ Environmental mitigation description and location
- ◆ Citation of source of mitigation requirements (e.g. Environmental Impact Statement, or Biological Opinion)
- ◆ Reference to cultural resources recovery information and identification of cultural resource sites (if it is determined, on a case-by-case basis, that there is need for O&M personnel to be aware of cultural resource sites)
- ◆ Care and management of mitigation vegetation and in-stream woody material (IWM) that differs from established instructions
- ◆ Amendments to Project Partnership Agreement
- ◆ Revised map of levee if there is a change to levee alignment
- ◆ Changes to non-project features in connection with bank protection (e.g. utility relocations, recreation facilities)

3.2 Real Estate Acquisitions and Permits

Often additional rights of way and easements are acquired for construction of bank protection and for mitigation. Existing easements may be modified and/or new easements/property rights may be acquired to accommodate the new bank protection requirements. For instance, flood control easements may be revised to include management and preservation of riparian vegetation. Supplemental manuals are a good venue to inform O&M managers of these changes. Temporary construction easements (TCE) should not be reported, as these are

terminated after a period of time; however, if said TCEs are required for an extended period of time due to mitigation establishment requirements, the TCE termination date and requirements should be noted. Lands and easements are the purview of the State of California. Permits are managed by the non-Federal sponsor, the Central Valley Flood Protection Board. Contact information should be referenced in case there is a need for further information on real estate acquisitions and permits.

Negotiated settlements with adjoining property owners and/or utility companies may involve new encroachment permits, joint use agreements, etc., therefore, reference to these new requirements and property rights can be included in the supplemental manual.

Environmental mitigation banks are often used as off-site mitigation. It is generally not the duty of O&M managers to inspect or otherwise contact mitigation banks; therefore, there generally is no practical need to provide information on off-site mitigation banks.

4.0 Preparation, Review and Approval

Authority for approval of O&M manuals is delegated from the South Pacific Division Engineer to the Sacramento District. Delegation of this authority is covered in a memorandum dated June 18, 2010, subject: Delegation of Approval Authority for Operation, Maintenance, Repair, Replacement, and Rehabilitation (OMRR&R) Manuals.

The maintenance of O&M manuals is the responsibility of Operations Division, Sacramento District. Revisions are typically assigned to Civil Engineering Branch, Engineering Division, in the Sacramento District.

5.0 Supplemental Manual Template

The SRFCP Supplemental Manuals are organized in a standard fashion. When bank protection projects are added to a levee in a maintenance unit, changes to sections of manuals should be done with care to preserve organization, consistency, and readability. Changes should be noted on a schedule at the beginning of the manual.

The following table is a template for revisions to Supplemental Manuals in response to new bank protection. This template is meant as a guide for where additions and revisions are to be placed. The table follows the organization of a typical Supplemental Manual. Annotations are highlighted in *grey italics* that show where information regarding bank protection should (or could) be added. If there is no highlighted annotation, this template does not anticipate a need for additions or revisions due to SRBPP construction. This does not preclude changes and additions to these sections if later found to be useful and appropriate.

The template table used as a sample the Supplemental Manual to unit number 115, East Levee of Sacramento River from Sutterville Road to North Boundary of Reclamation District Number 744. However, a Section 2-06, Real Estate, was added to accommodate changes to rights of way, etc.

Table 1 - Supplemental Manual Template

LISTING	ITEM	NOTES, Bank Protection Revisions-Addendums
	Cover	
	Additions / Revisions Log	<ul style="list-style-type: none"> Table noting revisions to the Supplemental Manual. <i>Revisions & additions due to bank protection are included.</i>
	Table of Contents	
	Section I - Introduction	
1-01	Location	
1-02	Project Works	<ul style="list-style-type: none"> Extent of levee, identification of other major SRFCP features. <i>Bank Protection authority, bank protection works are listed.</i>
1-03	Protection Provided	<ul style="list-style-type: none"> Brief description of flood plain behind levee, design flow
1-04	Construction Data and Contractor	<ul style="list-style-type: none"> Listing of history of levee work, including description, location, contract number, reference to contract drawings. <i>Bank protection construction should be added here.</i>
1-05	Flood Flows	<ul style="list-style-type: none"> Definition of floodflows, for the purposes of the manual. Example is high water at a specified elevation and location.
1-06	Assurances Provided by Local Interests	<ul style="list-style-type: none"> May be state legislation citation or other source of assurance.
1-07	Acceptance by Central Valley Flood Protection Board	<ul style="list-style-type: none"> Correspondence that formally accepts the project is cited. <i>Acceptance of a bank protection project is noted here. Copies of correspondence are included in Exhibit F, Letter of Acceptance by Central Valley Flood Protection Board</i>
1-08	Superintendent	<ul style="list-style-type: none"> Name and address of local levee superintendent that the Corps may contact.
	Section II – Features of the Project Subject to Flood Control Regulations	
2-01	Levees	<ul style="list-style-type: none"> Brief description, reference to O&M requirements and special instructions in the Standard Manual, reference to check list in the Supplemental Manual. <i>If bank protection results in a major modification such as a setback levee or adjacent levee, the levee description should be edited as appropriate.</i>
2-02	Drainage and Irrigation Structures	<ul style="list-style-type: none"> List of pipes and other structures that extend through the levee, and references to drawings. <i>Revise if pipes or structures are relocated due to construction.</i>
2-03	Channel	<ul style="list-style-type: none"> Description of the channel (e.g. Sacramento River) References to O&M requirements check lists in the Standard and Supplemental Manuals. Patrolling and other operational requirements during times of flood flow.
2-04	Miscellaneous Facilities	<ul style="list-style-type: none"> Detailed instructions for inspections, O&M of levee cutoff walls, observation wells. References to O&M requirements in the Standard Manual. List of bridges, utilities, local drainage, and recreation facilities owned & operated by other entities. <i>This section would need to be revised if the bank protection results in changes to facilities.</i>

Table 1 - Supplemental Manual Template (continued)

LISTING	ITEM	NOTES, Bank Protection Revisions-Addendums
2-05	Environmental Protection	<ul style="list-style-type: none"> • Preservation/removal/replacement of live or fallen trees & vegetation. • Disposition of in-stream woody material. • Identification of mitigation areas. • Citation of sources of mitigation requirements (e.g. Biological Opinion, Environmental Impact Statement). • <i>On-site or near-site bank protection mitigation should be identified and special O&M requirements, if any, described. Mitigation banks need not be included.</i>
2-06	Real Estate	<ul style="list-style-type: none"> • <i>Lands acquisitions, changes to rights of way, modified and/or new easements that are connected with the bank protection</i> • <i>Changes to encroachment permits connected with bank protection</i> • <i>Temporary construction easements with extended termination dates that are required for bank protection</i>
	Section III – Repair of Damage to Project Works and Suggested Methods of Combating Flood Conditions	
3-01	Repair of Damage	<ul style="list-style-type: none"> • First responder procedure In the event of serious damage to public works.
3-02	Applicable Methods of Combating Floods	<ul style="list-style-type: none"> • Reference to the Standard Manual.
Exhibit A – Flood Control Regulations		<ul style="list-style-type: none"> • Reference to the Standard Manual.
Exhibit A1 – Location Drawing		<ul style="list-style-type: none"> • Map of the alignment and extend of the levee that is in the O&M unit. Reclamation District boundaries, towns, bridges, and major roads are shown. • <i>In the case of a setback or adjacent levee, the map is revised.</i> • <i>For fix in place bank protection the map need not be revised, but possibly the location of new bank protection could be noted.</i>
Exhibit B – “As Constructed” Drawings		<ul style="list-style-type: none"> • Drawings are listed by file number and title. • <i>Add bank protection drawings including file number, to this list.</i>
Exhibit C – Plates of Suggested Flood Fighting Methods		<ul style="list-style-type: none"> • Reference to the Standard Manual.
Exhibit D – Check List No. 1 – Levee Inspection Report		<ul style="list-style-type: none"> • Reference to the Standard Manual.
Exhibit E – Check Lists, Channels and Structures		<ul style="list-style-type: none"> • Check list forms for inspections of facilities, with instructions.
Exhibit F – Letter of Acceptance by Central Valley Flood Protection Board		<ul style="list-style-type: none"> • Correspondence on notification of project completions, emergency repairs, acceptance by sponsor, sponsor requests. • <i>Correspondence on formal notice of bank protection project completion by the Corps and acceptance by the sponsor are to be included here.</i>
Exhibit G – Semi Annual Report Form		<ul style="list-style-type: none"> • Sample Semi Annual Report Form.
Exhibit H – Local Cooperation Agreement		<ul style="list-style-type: none"> • Local cooperation agreements, declarations of financial capability. • <i>For bank protection construction, add local cooperation agreements, project partnership agreements, declarations of financial capability, and associated pertinent correspondence.</i>

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Subappendix 8. Safety Assurance Plan Outline



SAFETY ASSURANCE PLAN OUTLINE SACRAMENTO RIVER BANK PROTECTION PROJECT

1) Preface

- a) Public safety is a primary Corps of Engineers (USACE) concern.
 - i) The term “public safety” includes public health and welfare
 - ii) Public safety is a primary consideration for every flood risk management (FRM) project
- b) Independent External Peer Review , Safety Assurance Review
 - i) Sacramento River Bank Protection Project (SRBPP) may be subject to an Independent External Peer Review (IEPR) Type II, also referred to as a Safety Assurance Review (SAR).
 - ii) The purpose of the SAR is to ensure that good science, sound engineering, and public health, safety and welfare are the most important factors that determine a project’s fate.
 - iii) The intent of the SAR is to establish the procedures for ensuring the quality and credibility of USACE decision documents through independent review.
 - iv) SAR Description
 - (1) An SAR will be conducted on design and construction activities for Flood Risk Management projects.
 - (2) A review will be conducted prior to initiating construction & periodically thereafter until construction activities are completed (WRDA 2007).
 - (3) The review is accomplished by an independent panel of experts that are shown to have no conflicts of interest.
 - v) Basis for SAR – Authority and Guidance
 - (1) The review plan was established by Section 2035 of the Water Resource Development Act (WRDA) of 2007.
 - (2) Current USACE guidance on conduct of SARs (guidance at the time of this outline) is Engineering Circular (EC) 1165-2-209, Civil Works Review Policy.
 - (a)
- c) Program Background, Description of SRBPP

2) Purpose of this Safety Assurance Plan

- a) Provides a strategy of review of public safety factors associated with the SRBPP in a comprehensive fashion (not site-by-site).
- b) Serves as a guide or checklist to assure that bank protection design and construction reduce as much as practicable risk to public health and safety, and thus facilitate Type II IEPR SAR (if a SRBPP SAR is conducted) .
- c) This plan might be provided to the Type II IEPR independent panel of experts as introductory material to demonstrate how public safety was considered in design and construction.
- d) Discuss SRBPP public safety effects in context with the Sacramento River Flood Control Project (SRFCP), and the overall Sacramento River flood control system.

3) Public Safety Factors

- a) WRDA 2007 lists the following public safety factors, used to determine if a project should undergo a SAR.
 - i) The failure of the project would pose a significant threat to human life;

- ii) The project involves the use of innovative materials or techniques;
- iii) The project design lacks redundancy;
- iv) The project has a unique construction sequencing or a reduced or overlapping design construction schedule.
- b) Other Public Safety Factors That Apply to SRBPP
 - i) Resiliency of the project to a range of flooding patterns and magnitudes.
 - ii) Other public safety threats in the event of project failure, besides threat to human life, such as threats to public health and welfare
 - iii) Potential public safety threats due to construction
 - iv) Local public safety threats caused by project facilities and their operation.

4) Sacramento River Flood Control Project Safety Assurance

- a) The SRBPP is constructed within the context of the SRFCP
- b) Description of the SRFCP (or reference description)
 - i) Large system of levees, weirs, bypasses
- c) Public Safety Aspects of the SRFCP
 - i) Hydrology depends on control of flows by dams
 - ii) Risk and uncertainty connected with levees
 - iii) Inherent resiliency and redundancy limitations of levees, of the levee and bypass system.
 - iv) Areas of high population
 - v) Public safety aspects of flooding of agricultural land
 - vi) Public safety aspects of flooding of infrastructure protected by levees

5) Sacramento River Bank Protection Project Safety Assurance

- a) Public safety aspects of the SRBPP
 - i) Erosion leading to levee failure as a factor of public safety
 - ii) Importance of banks as a line of defense against erosion of levees
 - iii) Innovative, unique aspects of incorporation of vegetation in bank protection designs.
 - iv) Assurances that state and Federal erosion monitoring is comprehensive, effective, and responds to public safety
 - v) Assurances that site selection and prioritization process is responsive to public safety.
 - vi) Assurances that the annual upward reporting process to justify funding is responsive to public safety.
 - vii) Bank protection measures' effectiveness and resiliency
 - (1) other measures, alternatives considered
- b) SRBPPP Construction effects to public safety
 - i) Risk of levee failure during construction
 - ii) Other public safety aspects of construction
- c) SRBPP facilities effects to public safety.
 - i) Concerns about localized public access to bank protection facilities.
 - ii) Operations and maintenance, including inspection, public safety aspects.
 - iii) Flood fighting effect to public safety.

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